Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

010 EMPIRE BUILDING | September, 1943 | PITTSBURGH, PA.

TECHNOLOGY DEPT.

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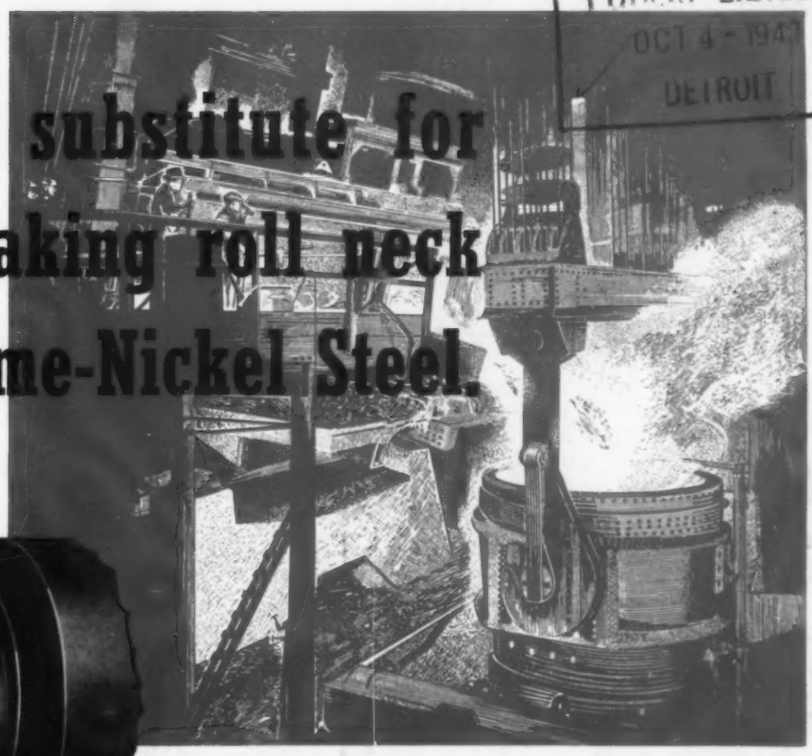
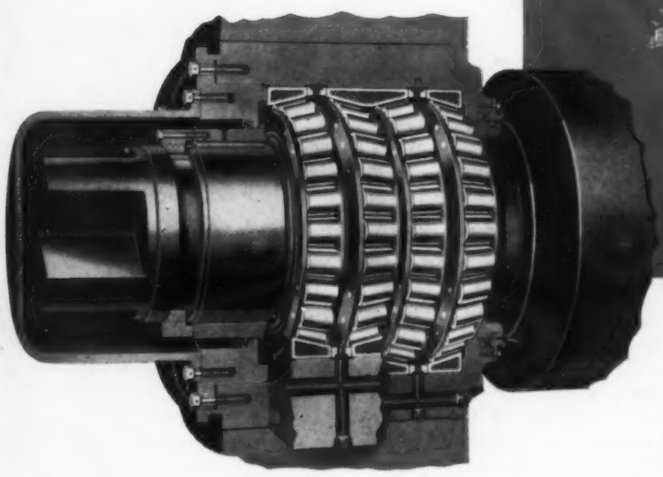
OCT 4 - 1943
DETROIT

There's no substitute for experience in making roll neck bearings of Chrome-Nickel Steel.





Timken Roll Neck Bearings have been manufactured of S.A.E. E 3310 Steel (with higher nickel content) for many years, the steel being produced in our own steel plant.

We originally adopted this steel for roll neck bearings because research and testing in our laboratories had proved it to be the best steel for this purpose.

However, in order to take full advantage of its desirable characteristics, it is necessary to know the steel intimately in every phase of its manufacture and fabrication — melting, rolling, forging, heat treating, machining.

This knowledge cannot be gained in a few weeks or months; it requires years of actual experience in the making of the steel and the making of the bearings. Thus there can be no substitute for the combined experience of our metallurgists; steel makers; and bearing manufacturers. That is why Timken Roll Neck Bearings made of Chrome-Nickel Steel have an unapproached record of performance and endurance on many of the world's largest and most important rolling mills. The Timken Roller Bearing Company, Canton, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Answers to Many Pushbutton Control Problems

Cutler-Hammer's New Wide Range Line of Heavy Duty Pushbutton Stations offers an Unlimited Variety of Functional Combinations

● Now Cutler-Hammer offers a new line of Heavy Duty Pushbutton Stations (NEMA Type 1) for surface mounting and for flush mounting. The surface mounting enclosures accommodate from 1 to 8 Cutler-Hammer new unitized pushbuttons; the flush mounting constructions accommodate from 1 to 3 C-H unitized pushbuttons. The line provides the widest selection of functions and combinations available today and permits these stations to be "tailored" to your exact needs.

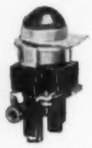
Among the many advanced engineering features are the following: one to 4 circuits for *each* pushbutton; wide variety of operators; big buttons for gloved-hand operation; projecting shatterproof color caps for 180° visibility; fitted "flange-seal" covers for extra sturdy and tight enclosure; rugged yet light weight construction; ample internal free space for easy wiring despite small size; no sharp corners or edges; excellent appearance; optional padlocking feature. Stations may be mounted horizontally or vertically. Write for further details today. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

ARMY E NAVY
Milwaukee Plants.

SOME OF THE OUTSTANDING FEATURES OF THIS LINE

Wide choice of operating elements with one to 4 circuits each, indicating lights, selector switches, etc.

Plain Pushbutton



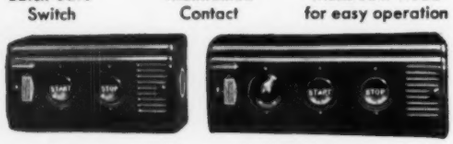
Indicating Light

Selector Switch

Latch-Safe Switch

Maintained Contact

Mushroom Head for easy operation



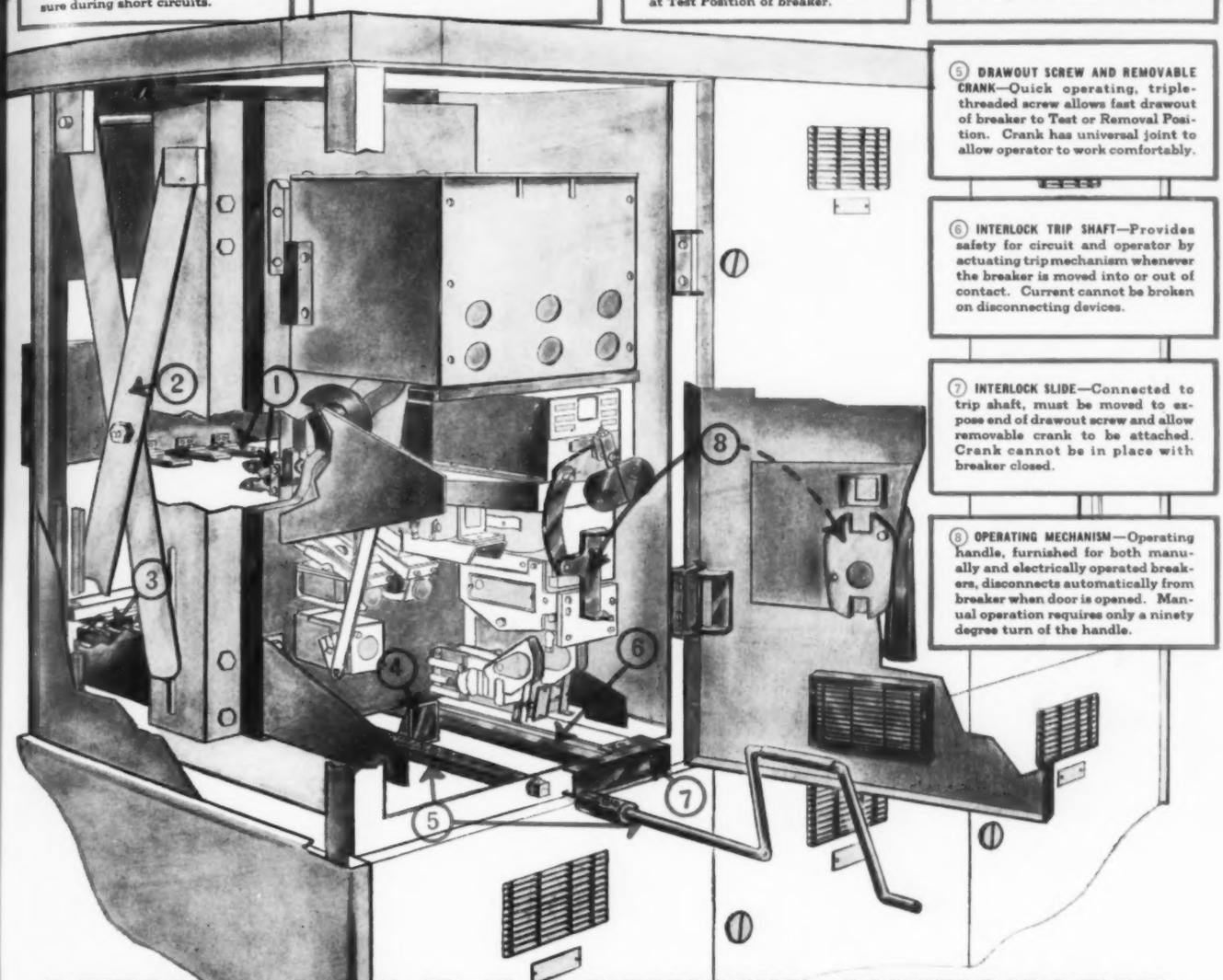
Horizontal as well as Vertical Mounting

Fitted Flange Seal Covers

Ample Wiring Space despite Small size

Padlocking Arrangement Available

CUTLER-HAMMER
MOTOR CONTROL
C-H



1 PRIMARY DISCONNECTING DEVICES—Self-aligning fingers on removable element allow safe inspection away from live parts. Silver plated for freedom from overheating. Divided current path increases contact pressure during short circuits.

2 PANTOGRAPH MECHANISM—A strong support for the circuit breaker, eliminates need for extension rails and saves time in removing breaker for servicing.

3 SECONDARY DISCONNECTING DEVICES—For control relay, auxiliary switch and other small wiring circuits. Self-adjusting, silver plated. Flexible members mounted on removable element. Contacts closed at Test Position of breaker.

4 POSITION INDICATORS—Breaker panel lines up with indicators when breaker is Closed, connected, or in Test Position. Protect breaker against being closed with disconnecting devices only in partial contact.

5 DRAWOUT SCREW AND REMOVABLE CRANK—Quick operating, triple-threaded screw allows fast drawout of breaker to Test or Removal Position. Crank has universal joint to allow operator to work comfortably.

6 INTERLOCK TRIP SHAFT—Provides safety for circuit and operator by actuating trip mechanism whenever the breaker is moved into or out of contact. Current cannot be broken on disconnecting devices.

7 INTERLOCK SLIDE—Connected to trip shaft, must be moved to expose end of drawout screw and allow removable crank to be attached. Crank cannot be in place with breaker closed.

8 OPERATING MECHANISM—Operating handle, furnished for both manually and electrically operated breakers, disconnects automatically from breaker when door is opened. Manual operation requires only a ninety degree turn of the handle.

DETAILS OF I-T-E DRAWOUT SWITCHGEAR ARE WELL WORTH YOUR STUDY

To know the details of Multumite drawout switchgear is to have in mind a measure for determining what you will one day want to specify--a useful guide when the time comes for new installation of completely metal-enclosed switchgear structures.

The advantages noted above are but a few of many. For a thorough description, have us send you Bulletin 4207 which plainly identifies and illustrates the features incorporated by I-T-E for safety and convenience in control and distribution of electric power.

I-T-E

AIR SWITCHGEAR

IMMERSED IN AIR • ENCASED IN STEEL

Representatives in Principal Cities

CIRCUIT BREAKER CO., PHILADELPHIA, PA.

NOW, industry's heaviest machines can be "bossed" by signals no more powerful than a cautious wink. Steel-mill flying shears and bomber gun turrets perform as if controlled by magic. Paper winder rolls are being regulated by the minute output of electric eyes.

Tomorrow, countless other machines will be obeying whispered signals initiated by power . . . motion . . . light color . . . sound . . . temperature.

The partnership of industrial electronics and G-E amplidynes—expertly matched by G-E engineers—opens vast new possibilities for stepping up milliwatts to kilowatts, with a fast and precise response to the slightest change in the input signal.

How does this partnership work?

The *milliwatt* output of detecting devices such as phototubes, selsyns, or pilot generators is first amplified electronically to about *one watt*. Instantaneously, the amplidyne adds another powerful boost, furnishing the *kilowatts* required to drive or control industrial machines.

The story of the amplidyne is interestingly told in "The Short Circuit That Moves Mountains". This booklet explains how amplidynes are being used to control speed, hold tension, speed up acceleration, provide automatic positioning. It shows why this G-E development has fostered an entirely new concept of automatic control. Ask for Bulletin GEA-4053. *General Electric Company, Schenectady, N. Y.*

With an electronic tube amplifying a .01 watt signal 100 times, and with the amplidyne in turn boosting it on up 10,000 times, amplification up to 1,000,000 to 1 is possible. If multi-stage electronic amplifiers are used and if the amplidyne is used to control a generator, over-all amplification (from the signal to the generator output) is way up in the billions.

GENERAL ELECTRIC

750-219-8456

AMPLIDYNES

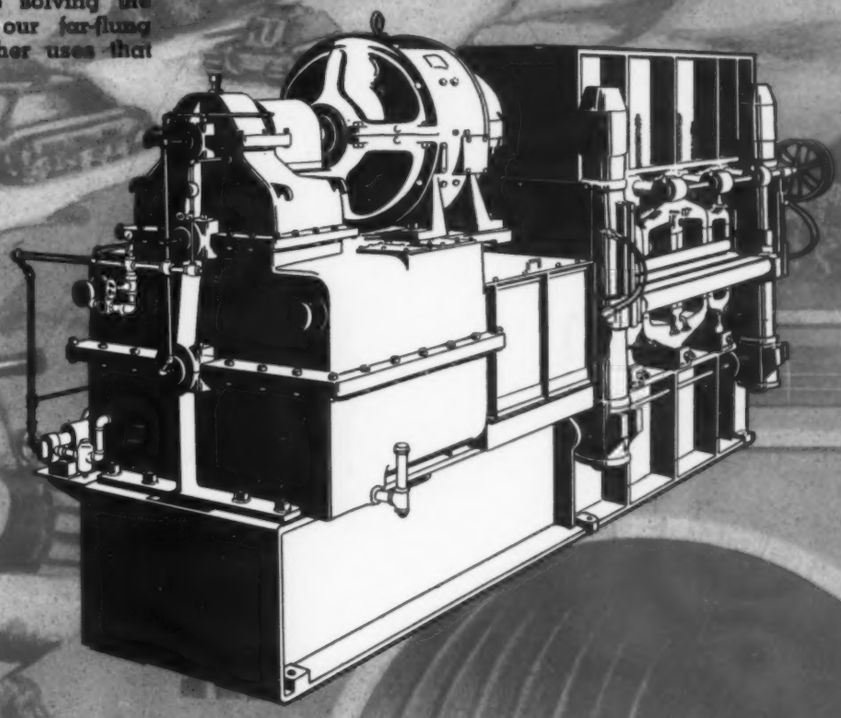
The best investment in the world is in your country's future—**BUY WAR BONDS**

AETNA LOOKS TO FUTURE HORIZONS

THE AETNA HEAVY DUTY LEVELLER

TODAY

● The Aetna Heavy Duty Leveller is levelling plate for many of today's urgent wartime demands. In tanks, which have proven to be outstanding in combat duty; for the record production of ships which are solving the problem of supply to our far-flung fronts, and for many other uses that are equally vital.



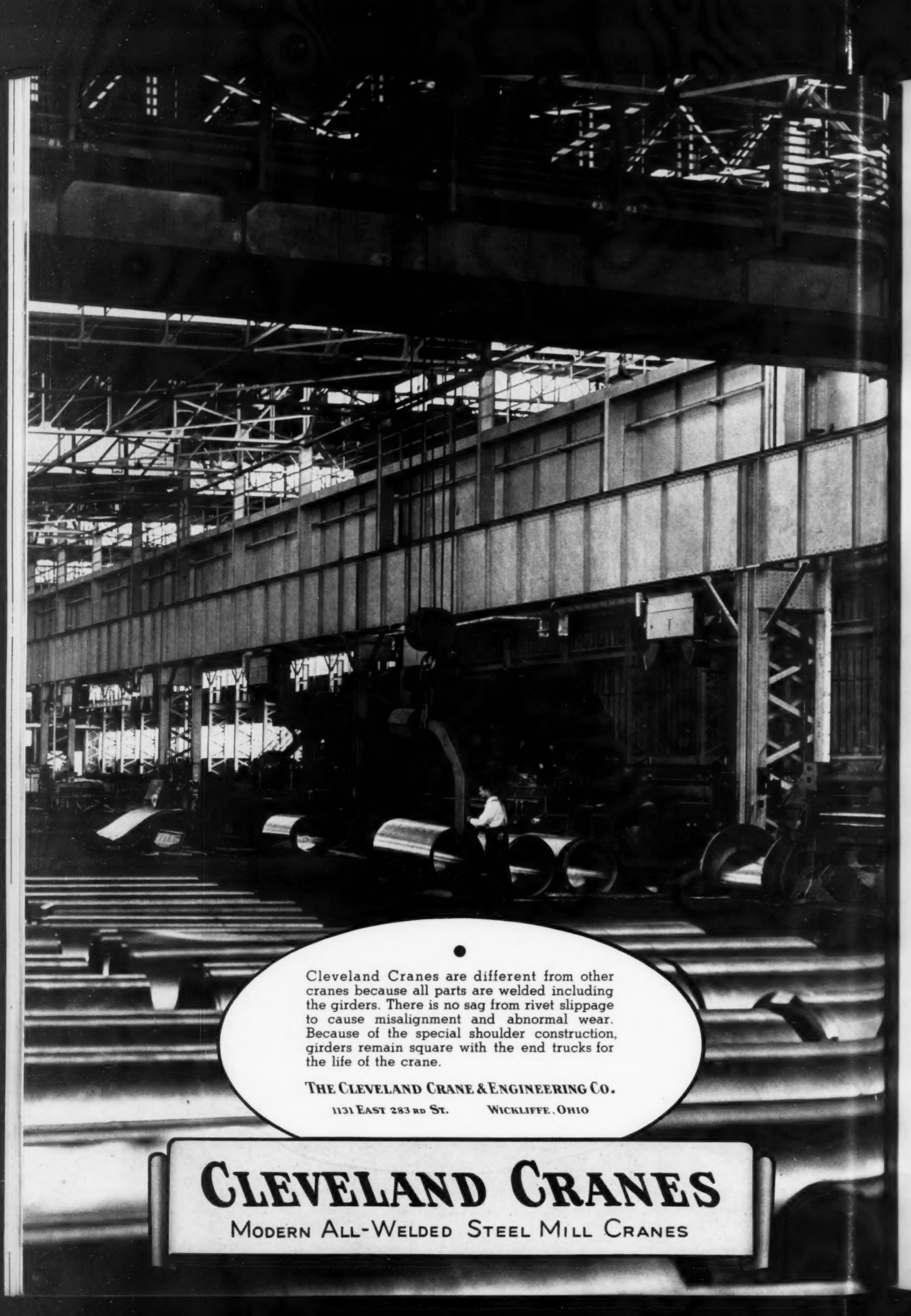
TOMORROW

● These same levellers, without any changes, will be performing in the period of reconstruction. Levelling plate for highway tunnels on express routes that will far exceed our most imaginative visions, or for ship plate for luxury liners in America's greatly expanded merchant marine. These and countless other uses will contribute to a new peace-time world.

The AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN · OHIO · U.S.A.
ARMY E NAVY

DESIGNERS AND BUILDERS TO THE STEEL, NON-FERROUS AND CHEMICAL INDUSTRIES

ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA



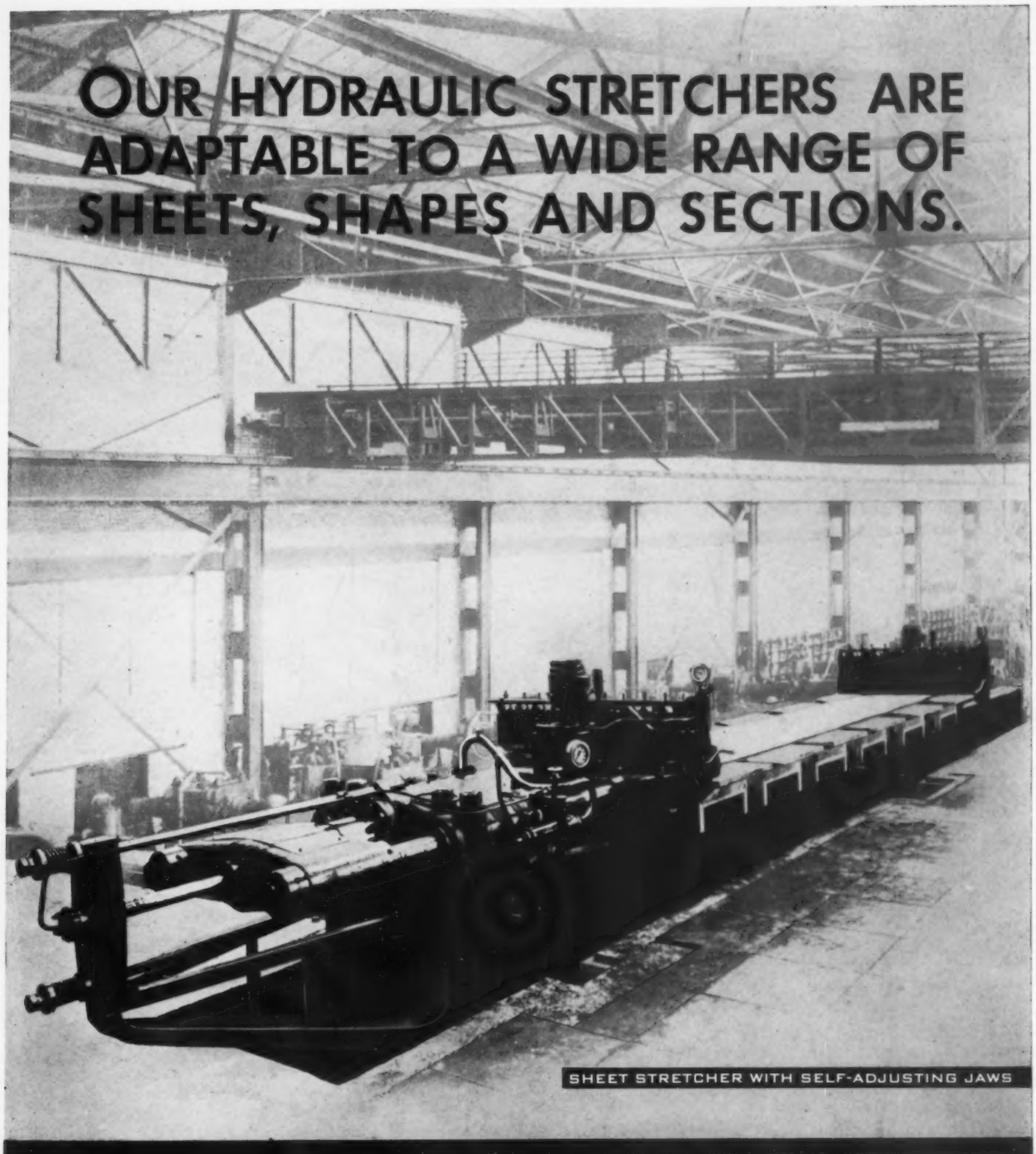
Cleveland Cranes are different from other cranes because all parts are welded including the girders. There is no sag from rivet slippage to cause misalignment and abnormal wear. Because of the special shoulder construction, girders remain square with the end trucks for the life of the crane.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES



SHEET STRETCHER WITH SELF-ADJUSTING JAWS

HYDROPRESS · INC.

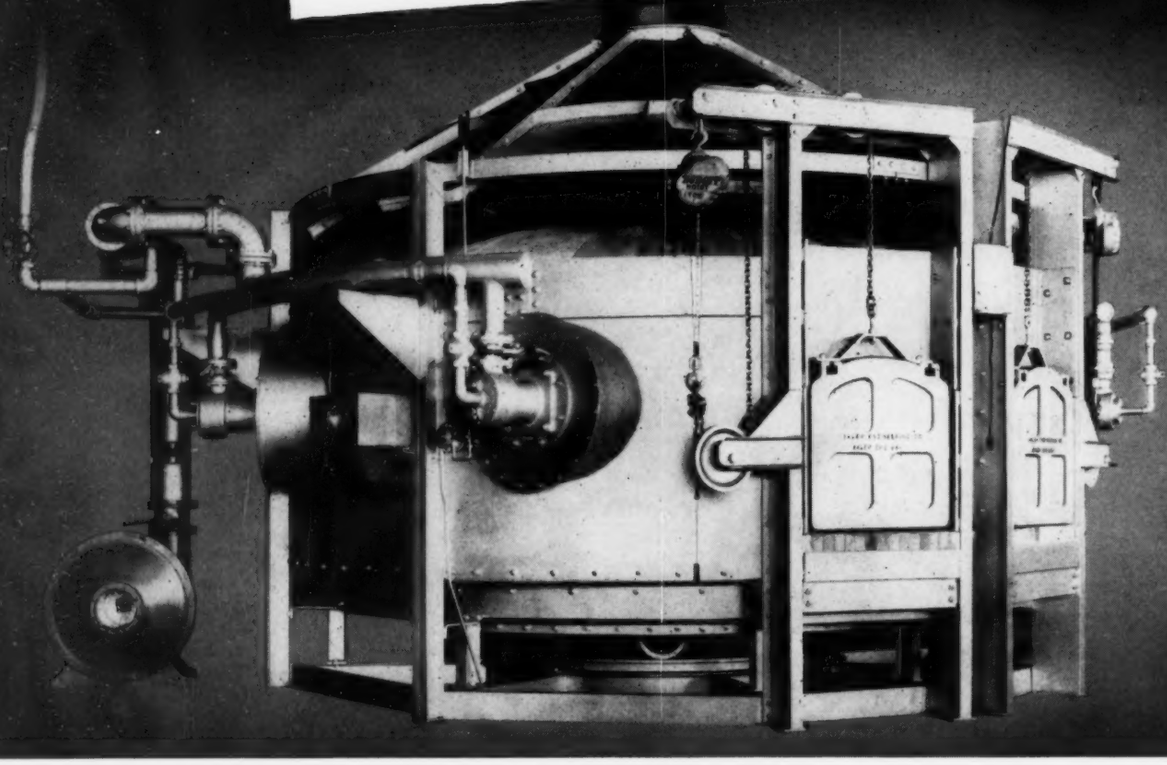
ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS
PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE · NEW YORK · N. Y.

INGENIOUSLY DESIGNED SALEM FURNACES HELP YOU

....SPEED PRODUCTION
....OBTAIN MAXIMUM UNIFORMITY
....REDUCE COSTS
....PREPARE for PEACETIME OPERATIONS



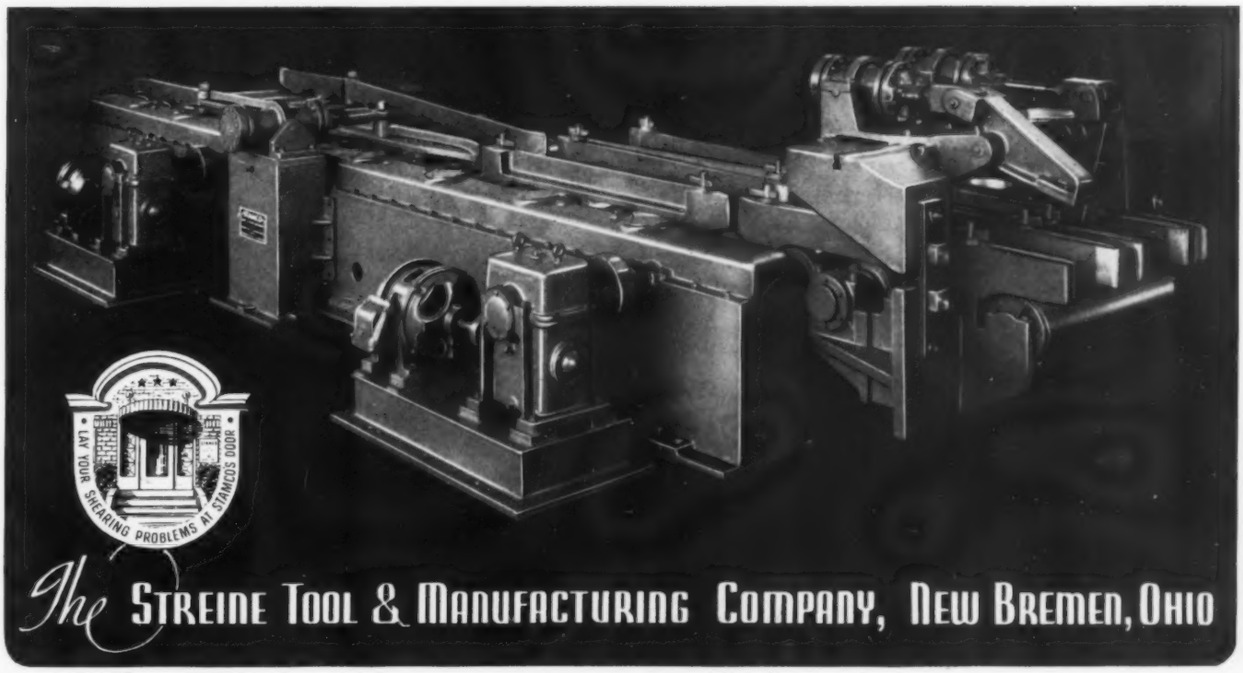
Every Salem furnace has its own special features which are applied to individual production requirements. Rotary Hearth Furnaces, for instance, are standardized by many manufacturers, but Salem furnaces are tailor-made — no "off-the-shelf" plans are used. Furthermore, by installing special features such as handling mechanisms, etc., furnace operations are coordinated with your production lines. An example of Salem's versatility in designing — the largest rotary hearth furnace in the world for heating steel carries the Salem trademark. • Salem Rotary Hearth Furnaces are ruggedly constructed; they give maximum heat treating uniformity, conserve fuel, have ingenious hearth movement, and permit big production from smaller floor space. Let Salem engineers help you to solve your present war production problem with a furnace that will also be valuable to your peacetime operations. And Salem has the ingenuity and experience to do it.

SALEM ENGINEERING COMPANY

SALEM ENGINEERING CO. · SALEM, OHIO

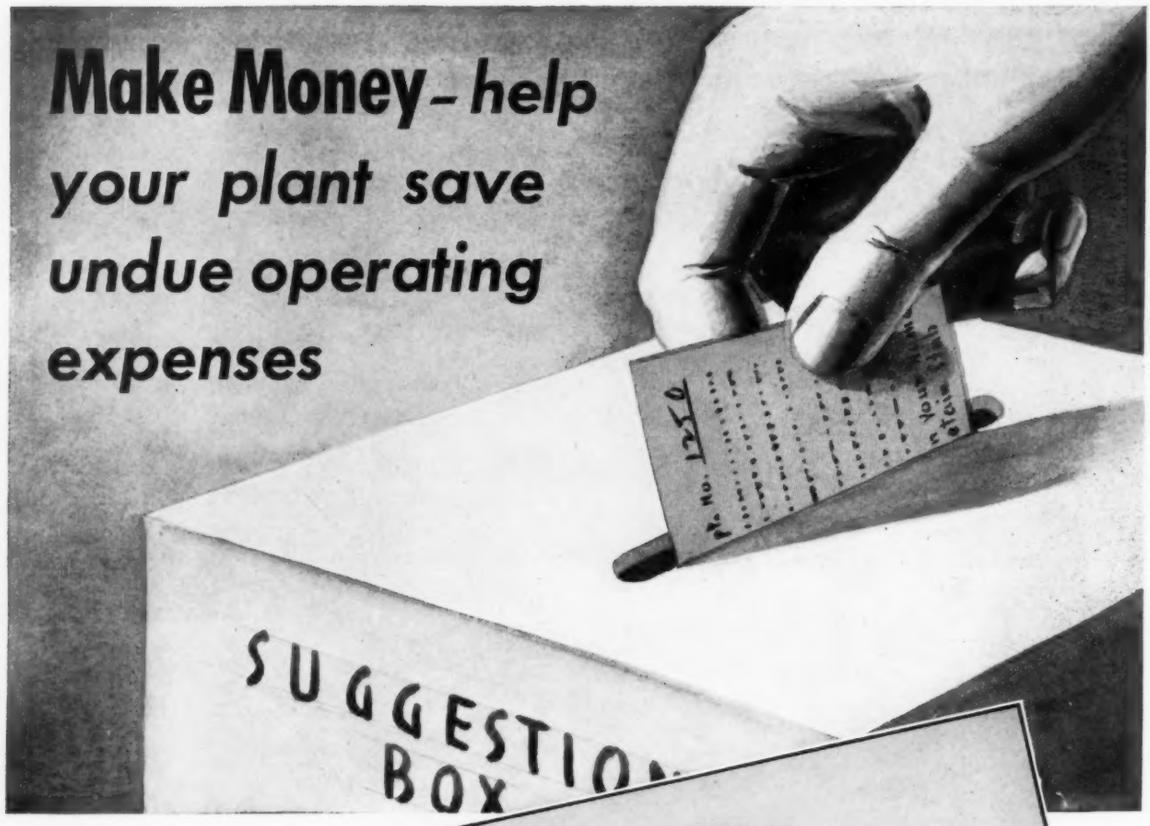
STAMCO

Special Heavy Duty Mill Type Tables



The STREINE TOOL & MANUFACTURING COMPANY, NEW BREMEN, OHIO

Make Money – help your plant save undue operating expenses



SAVE THIS STUB -S- -S- -S-

No. 2447

No. 2447 SUGGESTION BLANK

I SUGGEST that we install **Ryertex Bearings** wherever possible in our plant: blooming mills, plate mill, roughing stands, finishing stands, cold mills, pinion stands, bar mills, etc.

I believe the adoption of this suggestion will accomplish a distinct saving in power consumption; in lubricants (Ryertex is best lubricated by water); in bearing life (Ryertex outlasts other materials many times); in maintenance costs. Call the nearest Ryerson Plant for particulars.

Another good suggestion—Buy More War Bonds — for Victory

We'll back you up—with eye-opening performance figures on every type of bearing application. We'll follow up with quotations and any other necessary details. Get in touch with us for help.

JOSEPH T. RYERSON & SON, INC.
Plants at: Chicago . . . Jersey City

Crops *and* Shorts

AS long as we still have men in Washington who can laugh at a joke on themselves, perhaps we're not too badly off at that. J. A. Clauss, WPB Steel Division, sends us the following Prayer for Priority, which seems to have made a hit in Washington:

"Our father, who art in Washington, hallowed be thy name. Thy orders come, thy will be done out west as it is in Washington. Give us this day our authorization and permit us to operate so we may forgive those who close our plants against us. Add not to our hardships, but deliver us from red tape, for yours is the power to keep our country in glory forever and ever. Amen."

▲

REMEMBER when the waiter in the restaurant stood behind your chair with extra butter?

▲

OCTOBER 3-9 has been designated as fire prevention week. During the past year, fires have claimed 10,000 lives and a property loss of about $350,000,000. Approximately 31,000 fires occurred in industrial plants, with a loss of about $75,000,000. The metal working industry's share of this is reported as 1800 fires for a loss of $2,000,000, which is better than average. Perhaps a better way of thinking under present conditions, however, is to estimate the lives which might be lost because of a stoppage in steel production arising from a relatively insignificant fire in, say, a blooming mill motor.

▲

A READER tells us that an industrial engineer is a man who draws a mathematically precise line from an unwarranted assumption to a foregone conclusion.

▲

WOULDN'T it be nice if people with uninhibited zeal and uninhabited heads would stop to ascertain facts before throwing the brick? A case in mind is the recent charge by a representative of the United Steel Workers that one plant with ample rolling capacity refused to process excess ingots from another company because of the transportation cost involved. A subsequent statement by H. G. Batcheller avers that the excess ingots were being applied to the best advantage for the war effort. But it's fun to kick a guy in the pants, even if you have to apologize afterward.

▲

WHILE we haven't heard of its adoption in any of the steel producing plants, the showing of motion pictures during lunch hour is rapidly increasing in the various war plants. The practice is said to relieve fatigue and reduce absenteeism. Perhaps it won't be long before our inspectors are confusing the seams in billets with those in Marlene Dietrich's stockings, and the girl running the carbometer reports .54 per cent Gary Cooper.

▲

IT is not without certain pride that we announce an award to the Iron and Steel Engineer for editorial achievement. Submitted as an entry in the sixth annual competition of business papers, the "Specifications for Electric Overhead Traveling Cranes," published in the Iron and Steel Engineer for August 1942, received an award of merit for the best published research initiated by the publication. This recognition of our material, in competition with that of the other technical and business magazines of the country, justifies to some extent our efforts to give you the best publication in the iron and steel field.

▲

WE note from the War Manpower Commission's latest list of critical occupations that there is a shortage of parasitologists — wonder if they've considered the capable hotel house detectives.

▲

EVEN though the 1943 football season affords little ballyhoo, and even though the smell of burning leaves may be absent because Victory gardeners have put them in their compost piles, you can tell fall is here by the schedule of meetings of interest to steel men. In addition to the Iron and Steel Engineers' conference in Pittsburgh, September 28-30, the autumnal list includes the initial meeting of the new Electric Furnace Committee of A. I. M. E. in Pittsburgh, October 1-2; the National Safety Congress in Chicago, October 5-7; a regional meeting of A. I. M. E. Iron and Steel Division in Chicago, October 16-19; the A. S. M. and A. W. S. annual conventions in Chicago, October 18-22; and a joint fuels conference, A. I. M. E. and A. S. M. E., in Pittsburgh, October 28-29.

▲

THE annual engineering conference of the Association promises to be one of the most successful ever held. The program, published elsewhere in this issue, presents an imposing galaxy of speakers, including W. Sykes, president of Inland Steel Company, J. T. Whiting, director of WPB's Steel Division, and W. A. Irvin, United States Steel Corporation.

▲

THE swing from electric furnace steel to open hearth grades has apparently over-traveled, according to an appeal from J. T. Whiting, who asked that some alloys be shifted back to the expanded electric capacity in order to relieve open hearths for needed carbon steels.

BETTER FINISH INCREASED TONNAGE

Lewis Rolls are noted for toughness, tonnage and the superior finish they give the product.

★

LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX CO.
PITTSBURGH, PA.

LEWIS ROLLS

★ ★ ★ ★ FOR VICTORY BUY U. S. WAR BONDS AND STAMPS ★ ★ ★ ★

We are not permitted to show photographs of work in progress, but we can say that this work includes . . .

9—225 ton open hearths,

56 large Amco Pit Furnaces,

and 52 other furnaces including Amco Continuous Slab and Billet Heating Furnaces; Recuperative Side Door Heating Furnaces; Forging, Heat Treating and Annealing Furnaces, etc.

AMCO FURNACES FOR THE STEEL INDUSTRY

5

The AMSLER-MORTON Company

FULTON BUILDING · PITTSBURGH, PA.

FIRST CONTINUOUS HEAT TREATMENT OF TANK ARMOR PLATE

Before the war armor plate was heat treated in batch or pit-type furnaces—a slow, expensive process.

Even before Pearl Harbor we started working with one of America's largest steel companies developing a continuous type furnace, a furnace which could handle big tonnages accurately, quickly, and without an army of trained operators.

The final result was a group of continuous furnaces, each 100 feet long, for normalizing, hardening and drawing armor plate for tanks—the first furnaces of this type ever built for the production of armor plate.

They require fewer operators with so much less handling that there is no comparison. Formerly the management faced the dilemma of either building a larger heat treating building or of limiting production. But these new furnaces fit into the old building and have made possible huge production.

Since this installation practically all rolled tank armor is being produced in continuous furnaces of this type...and we have built them up to 320 feet in length.

Whether for armor plates, sheets or strip, rods, wire or tubes, a Surface Combustion furnace can be designed to deliver maximum work output at lowered cost. Surface Combustion builds furnaces for every steel mill heating operation, from ingot to the final end product.

SURFACE COMBUSTION • TOLEDO, OHIO

SC **SURFACE COMBUSTION**

MANUFACTURERS OF INDUSTRIAL FURNACES • JANITROL GAS-FIRED SPACE HEATING EQUIPMENT • KATHABAR SYSTEMS FOR DRY BLAST

SC Gas and Oil Fired Equipment For Every Industrial Need:
FORGING, NORMALIZING, ANNEALING, HARDENING, DRAWING, HEATING, CARBURIZING, NITRIDING. SPECIAL ATMOSPHERES. FOR DRY BLAST USE SC KATHABAR MOISTURE CONTROL SYSTEMS.

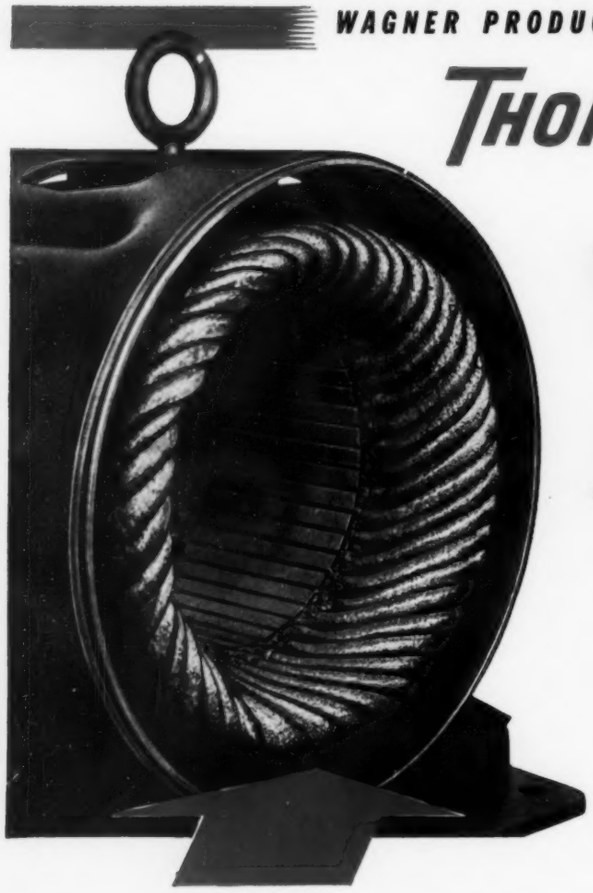
WAGNER PRODUCTS SPEED VICTORY!

THOROUGH INSULATION

...IS ONE OF THE REASONS WHY

Wagner MOTORS

Stay on the job!



The illustrations on this page show typical polyphase stator windings. The stator cores of all Wagner polyphase motors are well insulated, using special slot cells formed from tough fibrous material, cuffed on each end for extra strength.

The coils and free-ends are shaped to fit snugly into the slots so that there is no possibility of vibration and at the same time the windings are easily put into place.

Heavy separators are used between the coils in the slot and inverted U-shaped cells fit over the tops of the coils under the slot wedges. The free-ends of the windings are completely taped well into the slot cells, and heavy sheets of black varnished muslin are slipped between the coils of the various phases to insulate them from each other.

After the windings are in place, the stator is baked to remove all moisture, and while still hot it is immersed in a heavy insulating varnish. When the heated stator core is immersed in the much cooler varnish a suction is created which produces complete impregnation of the windings.

The stator is immersed long enough so that the insulating varnish impregnates the innermost portions of the coils. The stator is then baked again until this coating is completely dried. It is then given another dipping and baking to insure complete impregnation and to provide an added moisture-resisting coating.

Finally, the stator is sprayed with air-drying varnish, which not only provides further resistance to oil and moisture, but also gives the coils a glossy surface.

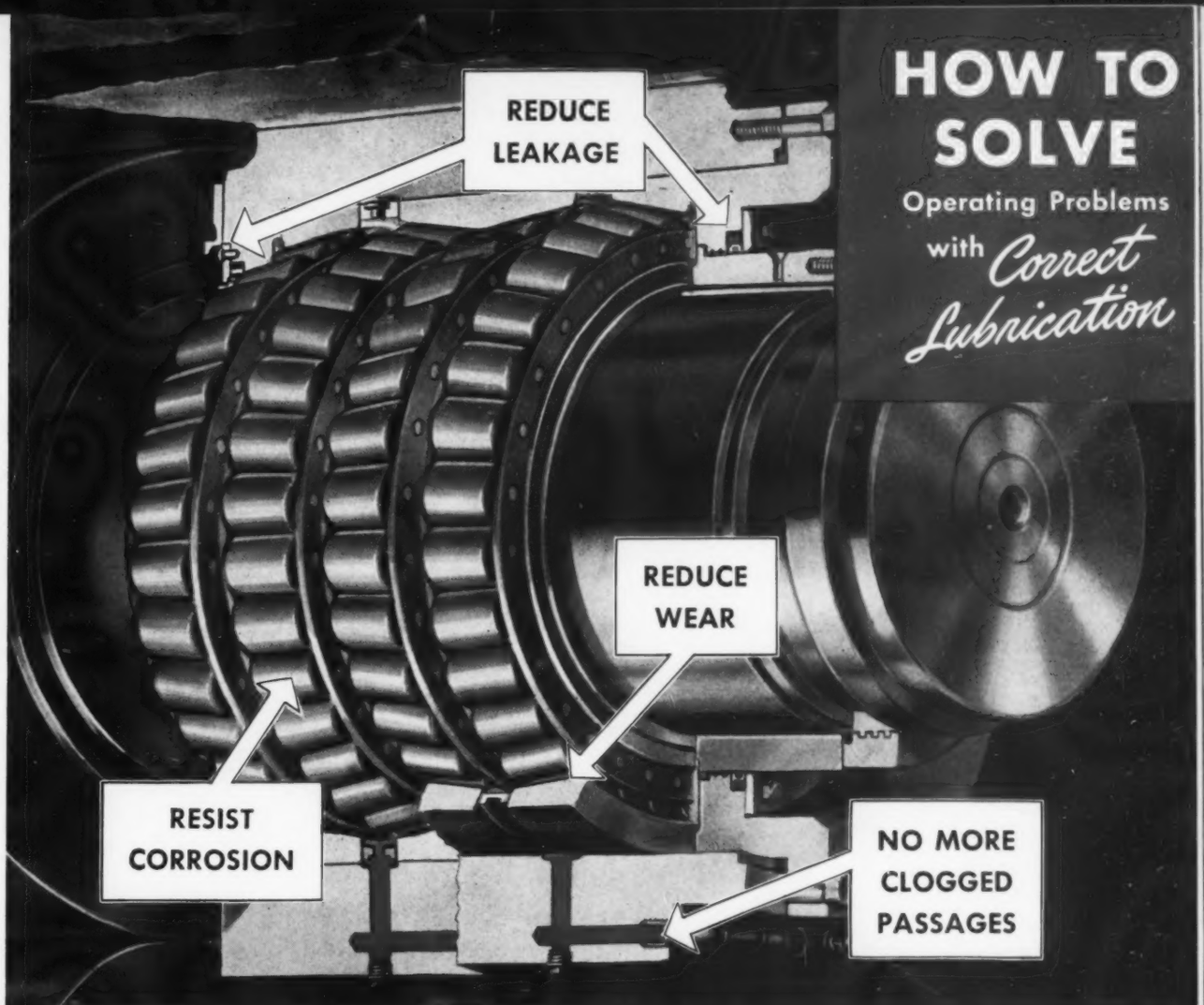
M43-17

WRITE FOR COMPLETE INFORMATION

Complete information on Wagner motors will be sent upon request. Wagner is a nation-wide organization with branches in twenty-nine principal cities. Each branch office is manned by trained field engineers ready to help you solve your motor-drive problems.

Wagner Electric Corporation
ESTABLISHED 1891
6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS

ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION



HOW TO SOLVE

Operating Problems with *Correct Lubrication*

Brand New Type Grease Ups Steel Mill Output!

HERE'S A NEW GREASE that was designed expressly for steel mill service — Gargoyle Sovarex L Grease. *There is no other grease made that combines all its properties!*

This grease has been extensively tested in service in some of U.S.A.'s largest steel mills. Where it was used formerly experienced wear disappeared. Machine outage time was materially reduced. Production increased.

The importance of this new grease to the steel industry cannot be overemphasized.

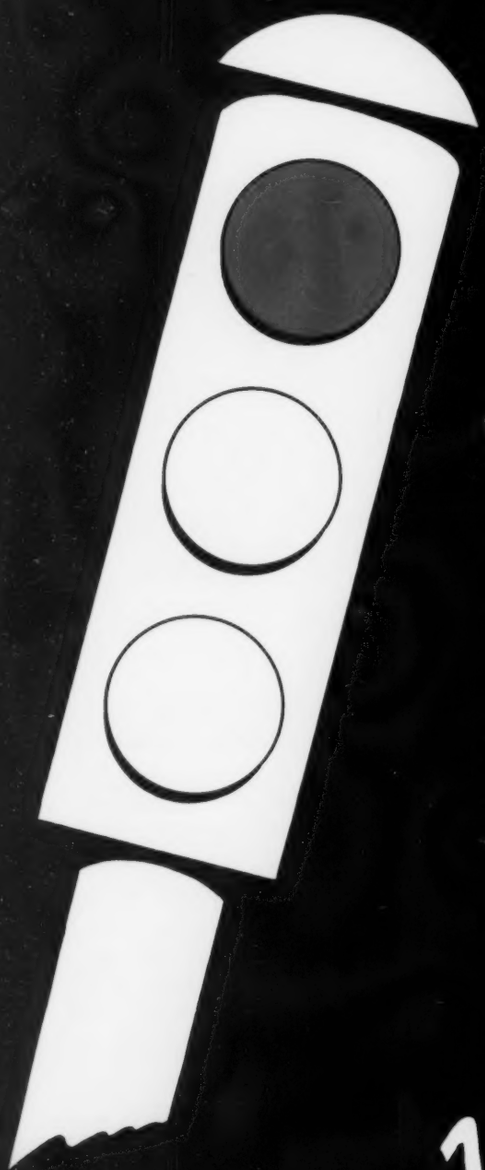
GARGOYLE SOVAREX L GREASE HAS THESE IMPORTANT ADVANTAGES:

1. Maximum resistance to softening at high temperature. *Result:* reduced leakage.
2. Resists water. Oil film stays put. *Result:* resists corrosion... prevents wear.
3. Resists separation. *Result:* oil lines and passage are not clogged... bearing failures from this cause prevented.
4. High consistency index. *Result:* permits easy feeding with temperature variations.
5. Extra load carrying ability. *Result:* maximum protection against wear.

GARGOYLE Lubricants

SOCONY-VACUUM OIL COMPANY, INC.— Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. White Eagle Div. • Wadhams Div. • Magnolia Petroleum Company • General Petroleum Corporation of California

USE SOVAREX L GREASE



STOP

Waste OF MAN HOURS

Waste OF MATERIALS

With

"TOOL STEEL" HARDENED PRODUCTS

* . . . last 5 to 10 times longer than soft steel products. (A tremendous saving of materials)

. . . save breakdown and replacement tie-ups. (A vital man hour economy)

THE TOOL STEEL GEAR & PINION CO

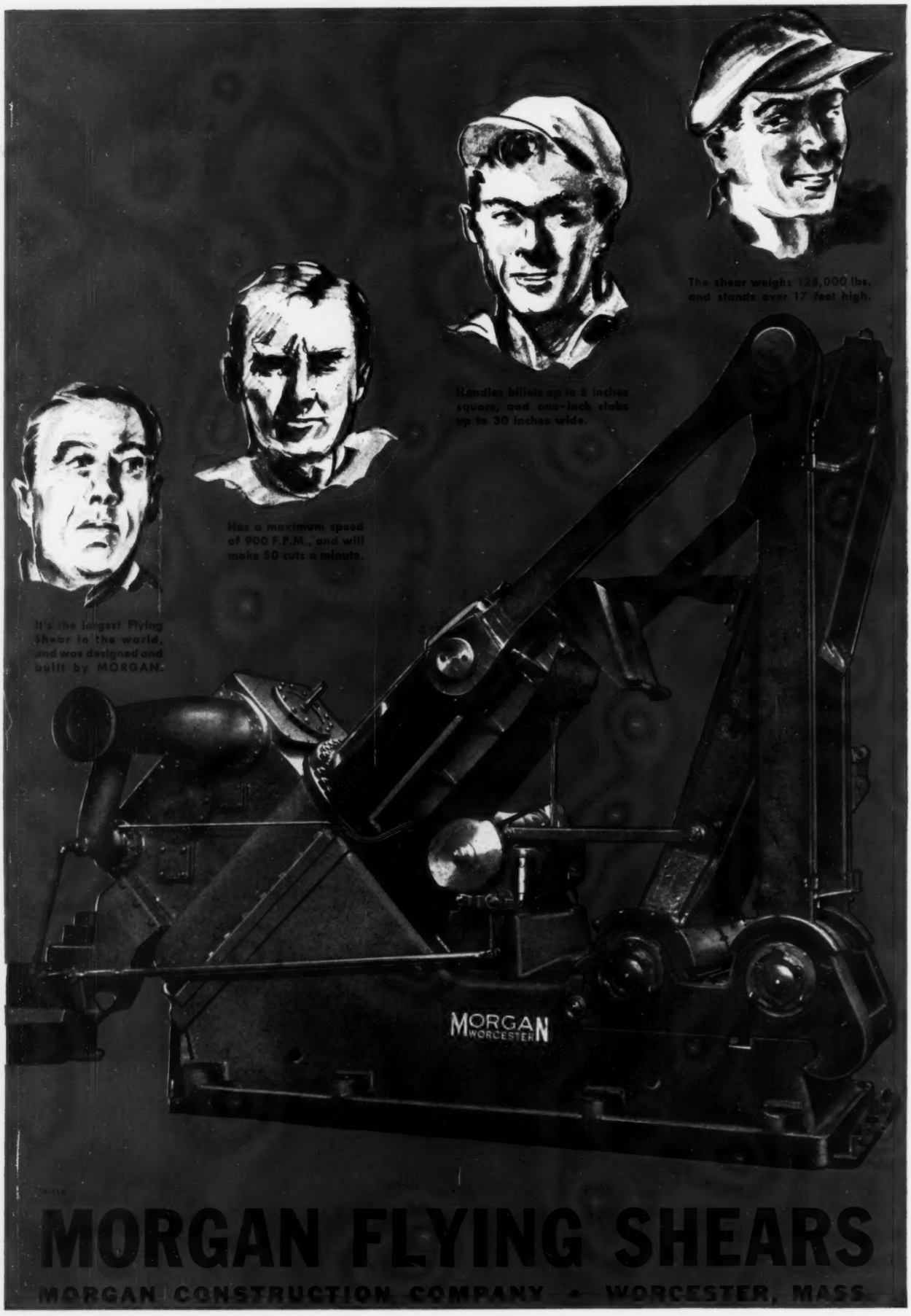
TYPICAL "TOOL STEEL" PRODUCTS

GEARS • PINIONS • ROLLS • BRAKE WHEELS

SCREWDOWN SCREWS AND NUTS • CRANE WHEELS

MILL HERRINGBONE PINIONS • SHEAVE WHEELS • SPROCKETS

ONCO. • • • CINCINNATI, OHIO

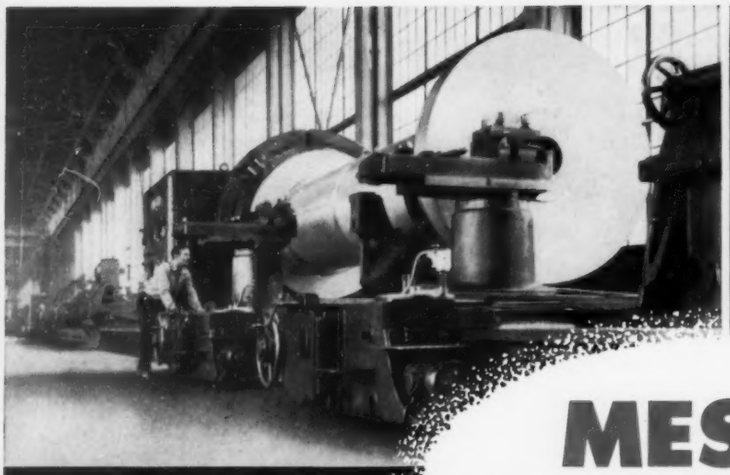

It's the largest Flying Shear in the world, and was designed and built by MORGAN.
Has a maximum speed of 900 F.P.M., and will make 50 cuts a minute.
Handles billets up to 5 inches square, and one-inch slabs up to 30 inches wide.
The shear weighs 125,000 lbs. and stands over 17 feet high.
MORGAN WORCESTER
MORGAN FLYING SHEARS
MORGAN CONSTRUCTION COMPANY • WORCESTER, MASS

The Army-Navy "E" Flag with three stars, flies over the Mesta plant.

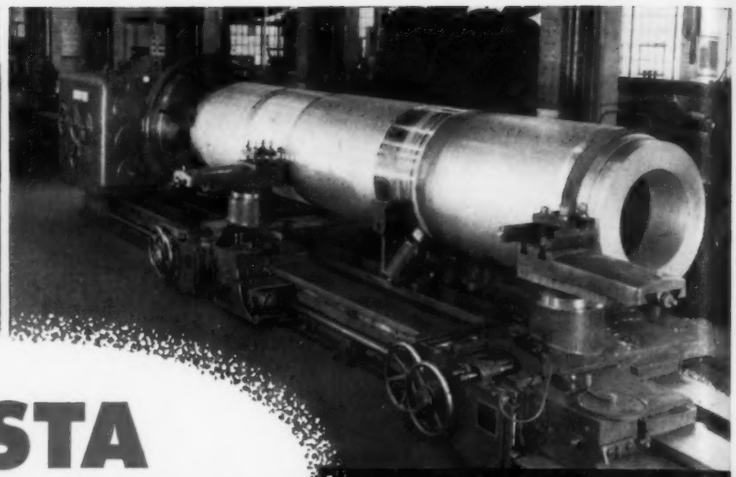
Pouring Open Hearth Steel
From One of the Furnaces at Mesta

MESTA MACHINE COMPANY . . PITTSBURGH, PA.

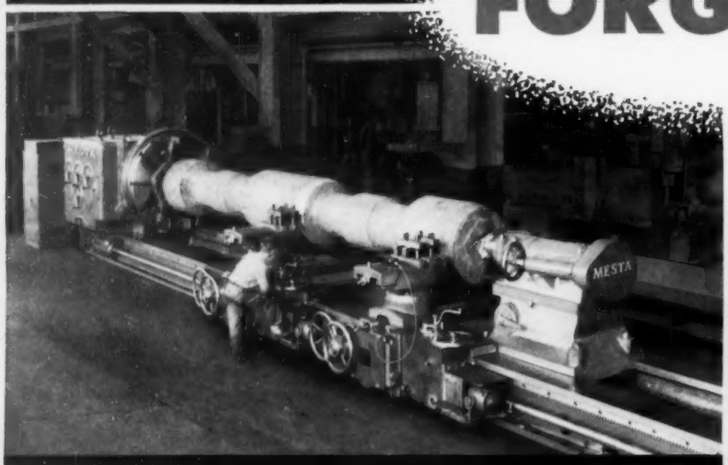
MESTA FORGINGS



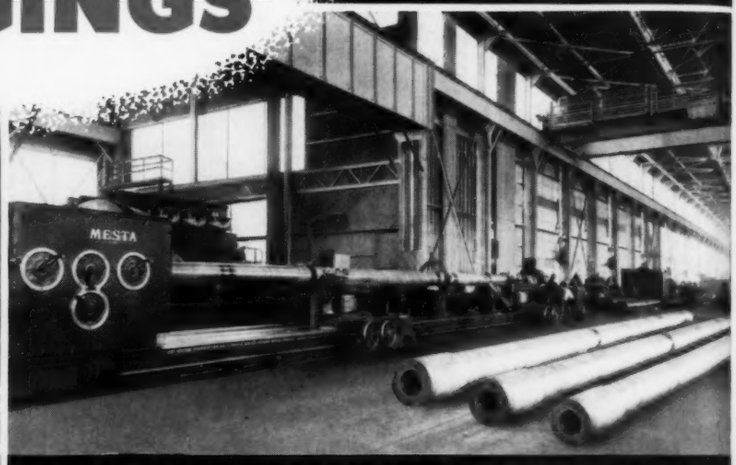
Massive Forged Rotor Shafts for Giant Turbines at the World's Largest Dams



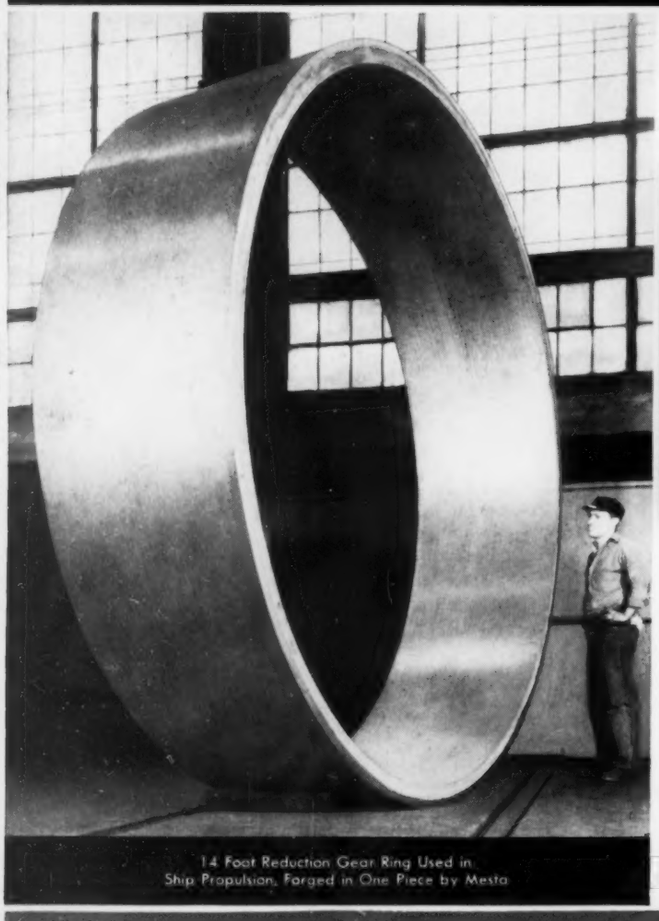
One Piece Forged Steel High Pressure Accumulator Bottle



An Intricate Forging Being Machined at Mesta



Propeller, Stern Tube and Line Shafts for Ships are Produced Complete in the Mesta Plant



14 Foot Reduction Gear Ring Used in Ship Propulsion, Forged in One Piece by Mesta

Group of Mesta Forged Hardened Alloy Steel Working Rolls for Cold Mills

The Army-Navy "E" Flag with three stars, flies over the Mesta plant.

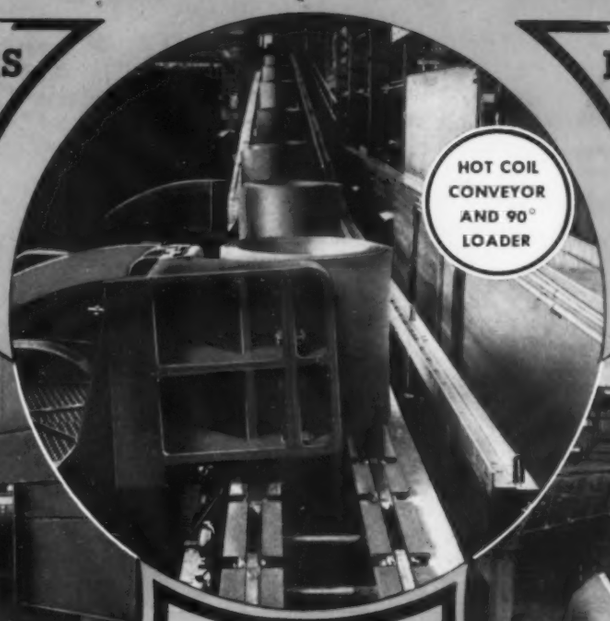
Group of Forged Steel Columns for 14,000 Ton Pure Hydraulic Forging Press

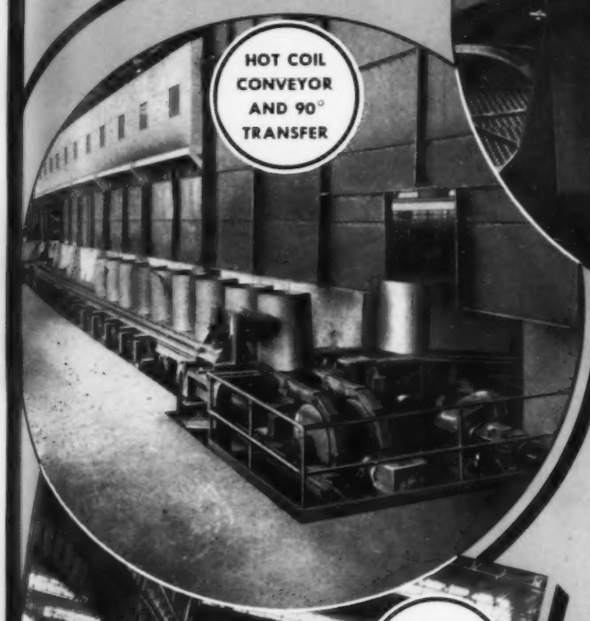
BUY MORE WAR BONDS

MESTA MACHINE COMPANY . . PITTSBURGH, PA.

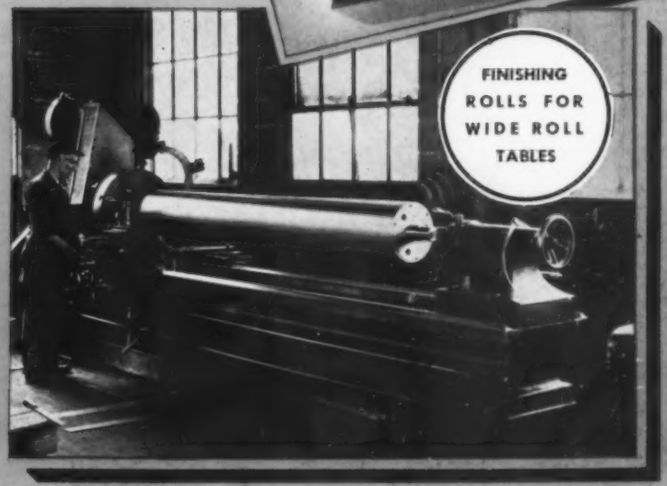
ENGINEERS & BUILDERS OF CONVEYORS AND AUXILIARY

EQUIPMENT FOR THE STEEL MILL AND NON-FERROUS INDUSTRIES

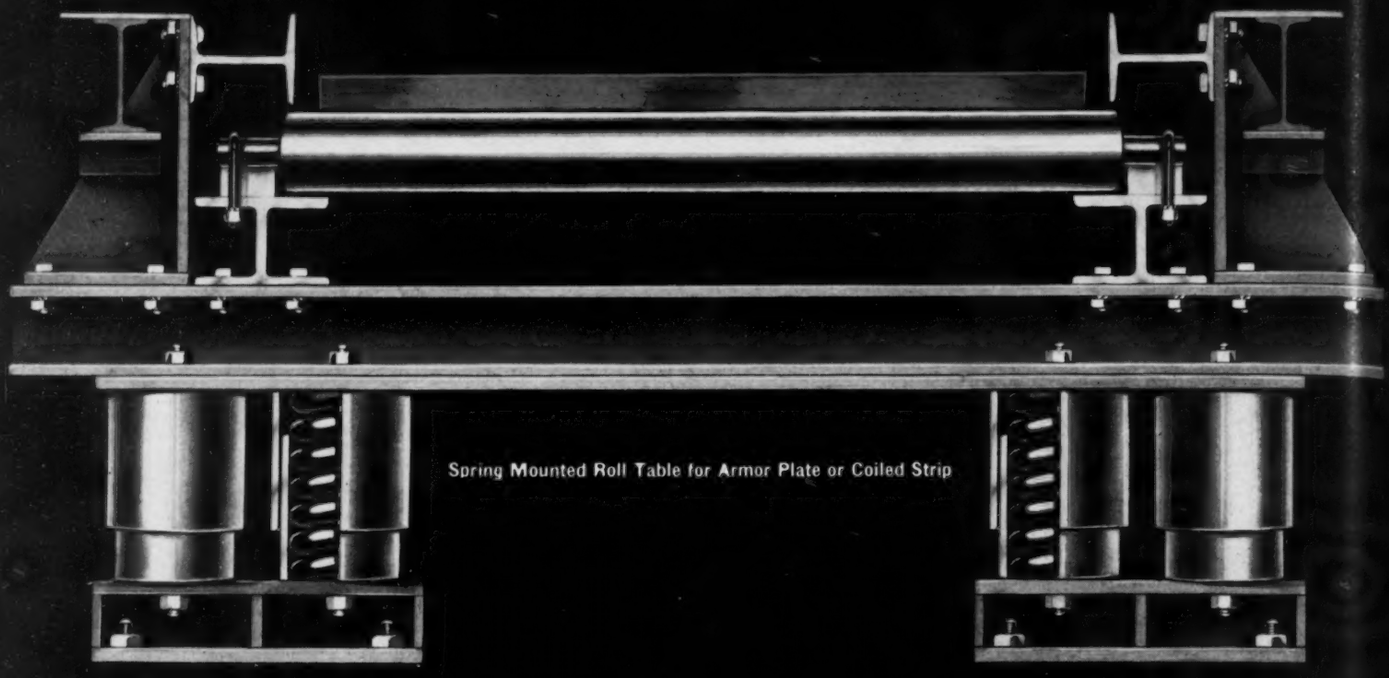




PALMER BEE

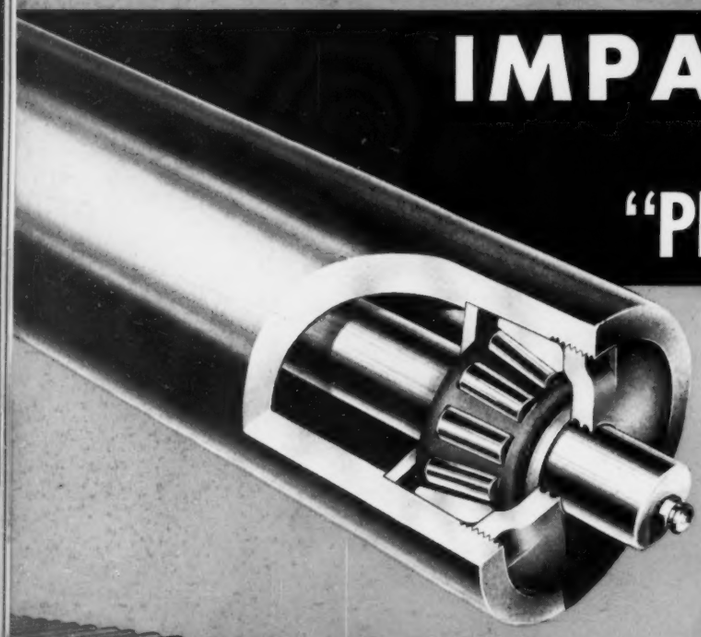


PALMER-BEE COMPANY, DETROIT

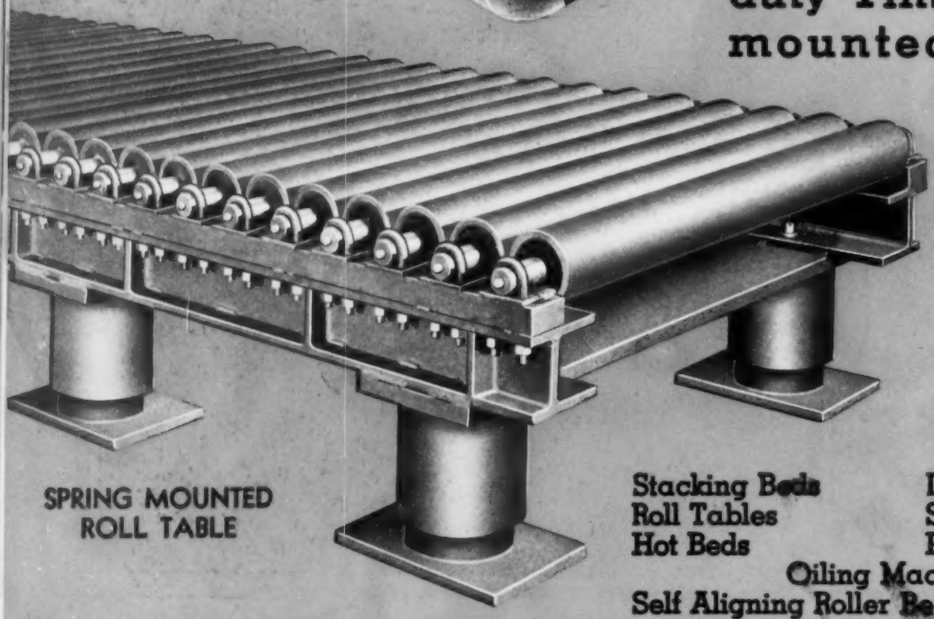


Spring Mounted Roll Table for Armor Plate or Coiled Strip

IMPACT *and* SHOCK CAN RETARD "PRODUCTION *for* VICTORY"



A suddenly applied load is the most destructive force encountered by Rolling Mill Conveyor Equipment. This force is met and absorbed by PALMER-BEE heavy duty Timken Roller Bearing Rolls mounted on spring supported structure. CAPACITY UP TO 30,000 LBS. PER ROLL.



SPRING MOUNTED ROLL TABLE

ENGINEERS AND BUILDERS OF STEEL MILL EQUIPMENT:

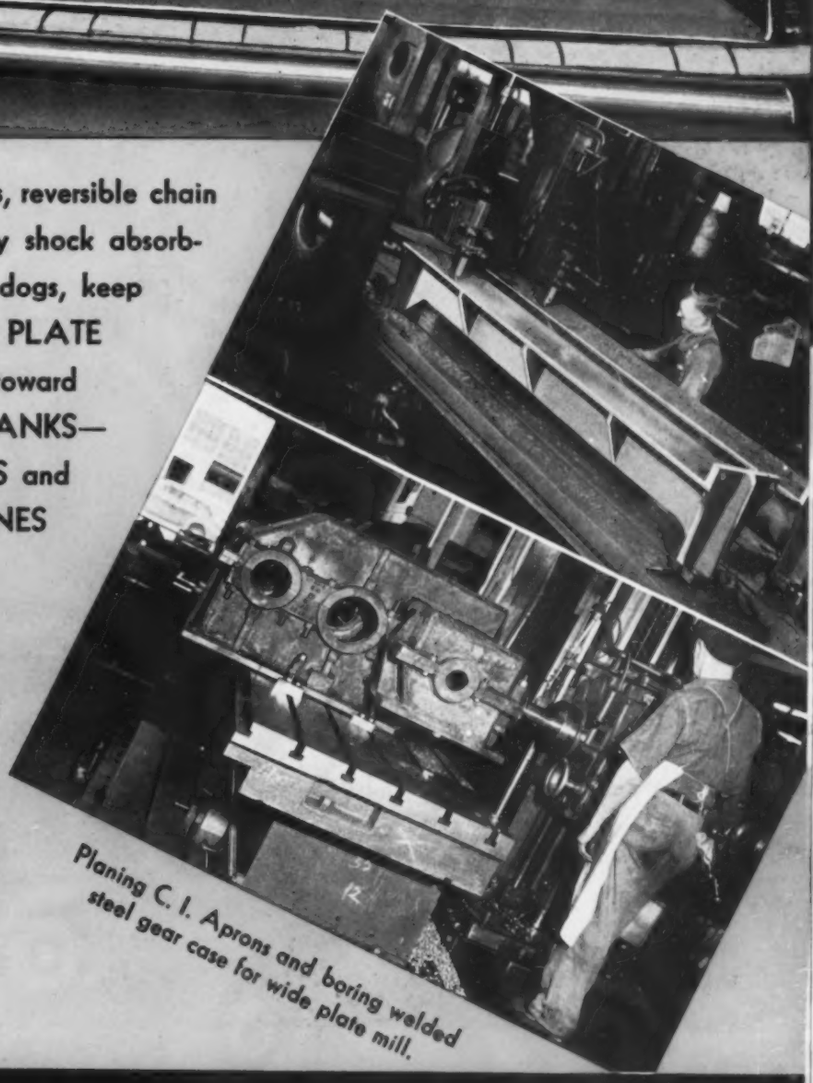
Up-enders and Down-enders
Soaking Pit Cover Lifters
Plate Turnover Rigs

Stacking Beds
Roll Tables
Hot Beds
Inspection Tables
Slab Transfers
Pilers
Tilters
Transfer Chains
Roller Conveyor
Oiling Machines
Coil Conveyors
Self Aligning Roller Bearing Pillow Blocks with Cast Steel Housing

PALMER-BEE COMPANY DETROIT

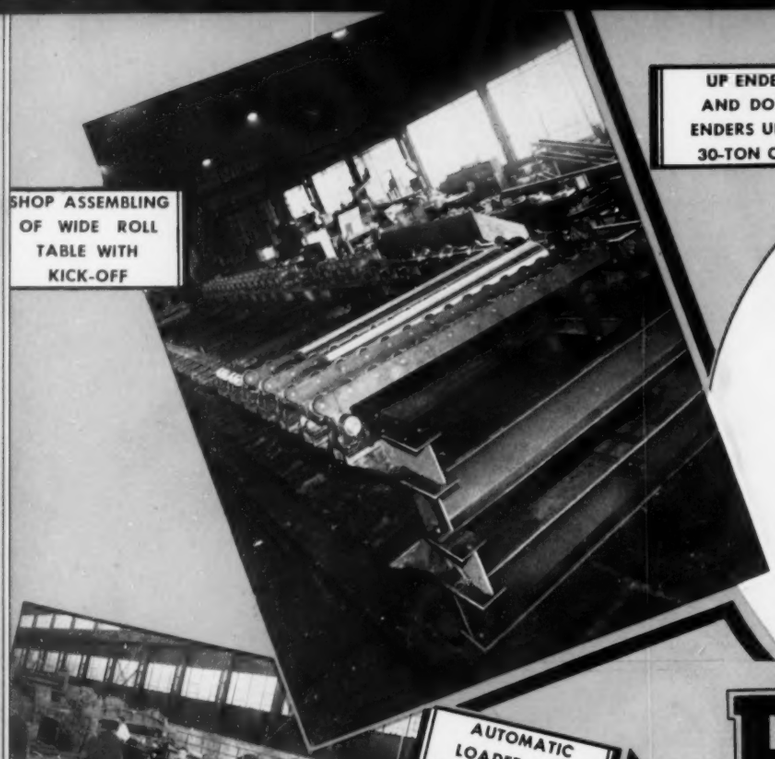
PALMER-BEE Run-in and run-out roll tables, reversible chain transfers with 2-way shock absorbing ducking dogs, keep ARMOR PLATE rolling toward SHIPS—TANKS—TRUCKS and PLANES

Up-ender receives red hot coils and sets them on conveyor without shock.



Planing C. I. Aprons and boring welded steel gear case for wide plate mill.

PALMER-BEE COMPANY DETROIT



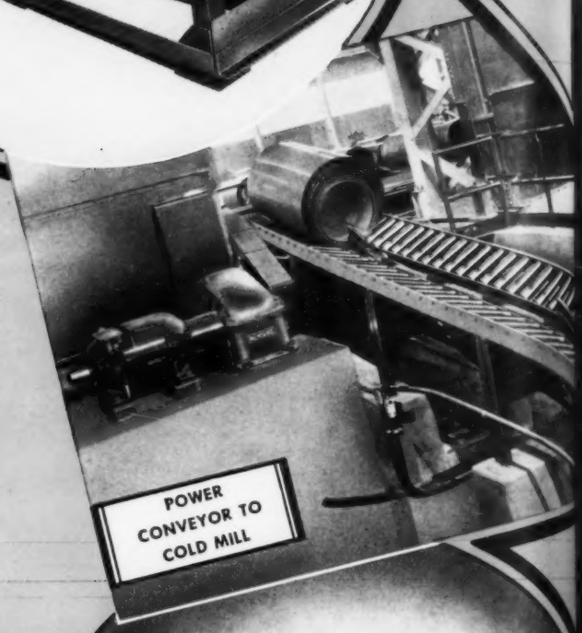
SHOP ASSEMBLING OF WIDE ROLL TABLE WITH KICK-OFF

UP ENDERS AND DOWN ENDERS UP TO 30-TON CAP.

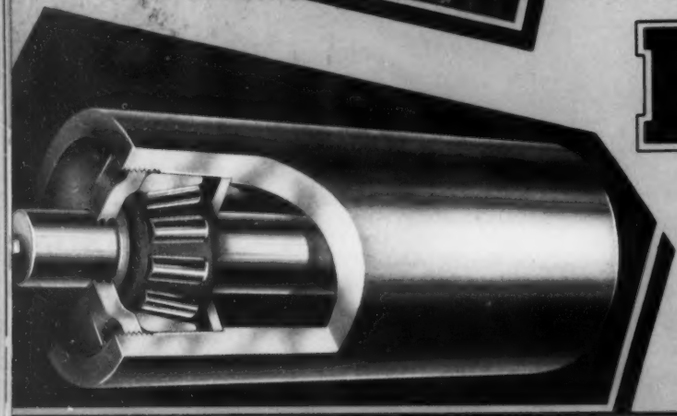
ENGINEERS & BUILDERS OF CONVEYORS AND AUXILIARY EQUIPMENT FOR THE STEEL MILL AND NON-FERROUS INDUSTRIES

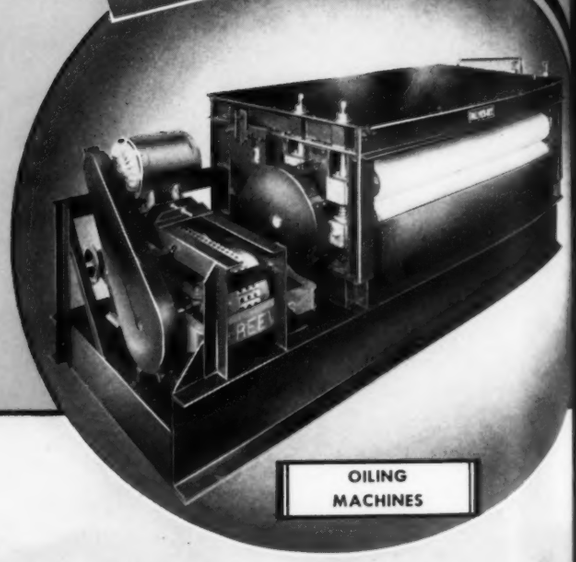
PALMER BEE

AUTOMATIC LOADER FROM PICKLER TO POWER CONVEYOR



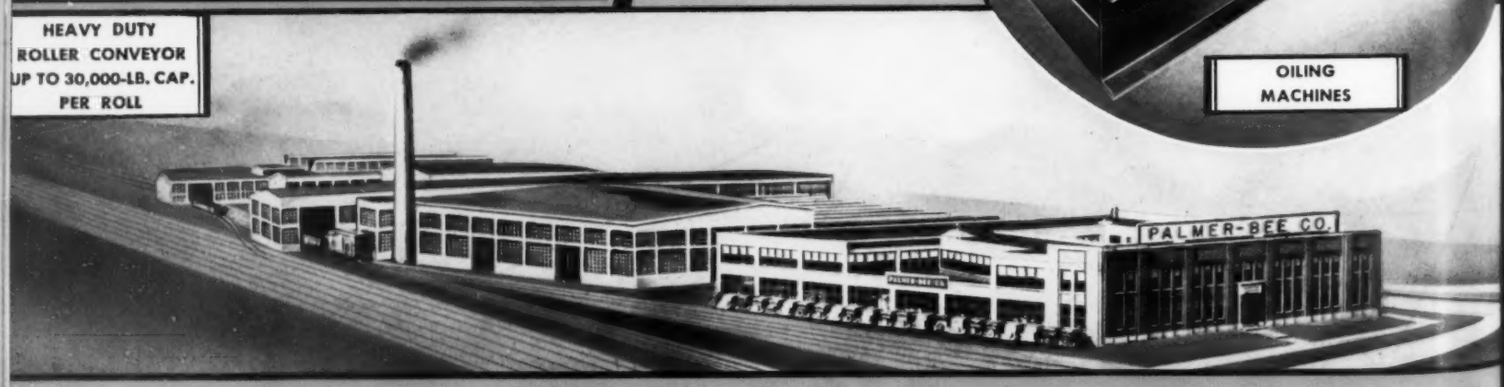
POWER CONVEYOR TO COLD MILL





OILING MACHINES

HEAVY DUTY ROLLER CONVEYOR UP TO 30,000-LB. CAP. PER ROLL



PALMER-BEE COMPANY, DETROIT

REPORTING *on the use of*

Linde Methods

in mass production..

SHIPBUILDING . . . A typical major industry where Linde methods speed production

Building the Victory Fleet faster than ships ever were built before . . . 16,000,000 tons of merchant shipping alone this year . . . requires mass-production methods using the most efficient processes available. Some of the most essential of these processes were developed by The Linde Air Products Company . . . developed to meet peacetime requirements . . . and adapted with Linde engineering help to meet the specialized mass-production needs of today.

As you turn this page, you will see how some of these Linde techniques are being used to speed production and save precious time and materials in shipbuilding . . . both in the yards and the outfitting docks and even in the mills making ship steel.

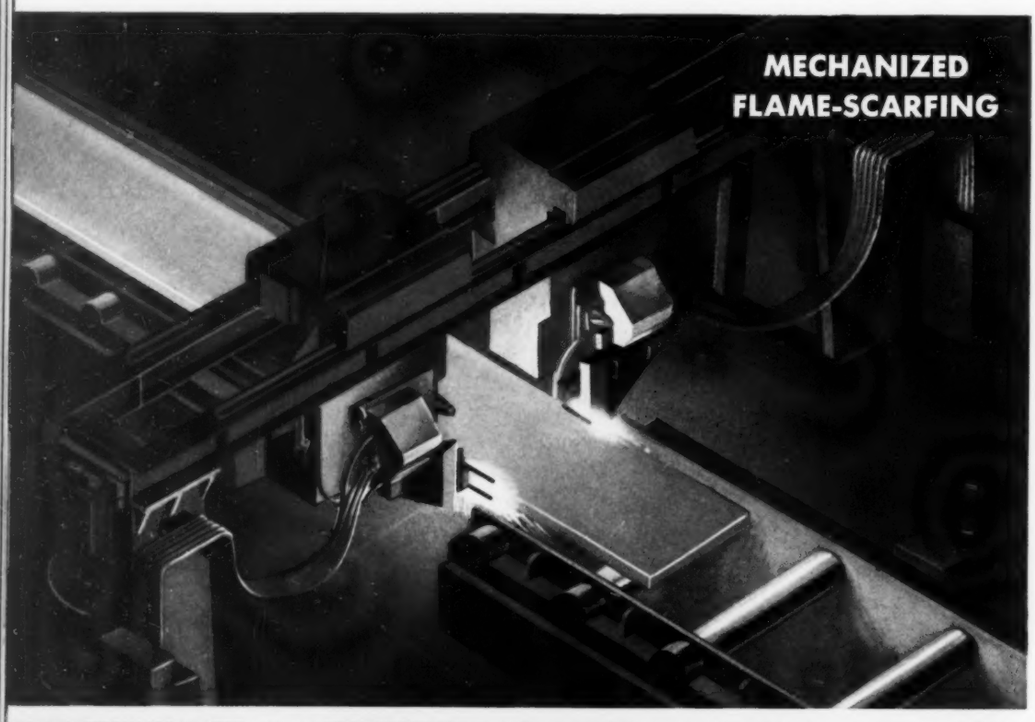
The shipbuilding industry is but one of many that are applying Linde's oxy-acetylene techniques . . . and Unionmelt electric welding . . . to specialized mass-production. Wherever metals are cut, formed, joined, or treated in essential industries, Linde developments are helping to do the job faster, better, and more economically. Every ton of steel produced and fabricated, as well as every ship constructed . . . calls for use of oxygen and acetylene and oxy-acetylene apparatus in increased quantities.

When you realize this, you will appreciate the importance of using productively . . . without waste . . . all supplies for these metal-working methods.

From STEEL to SHIPS Linde Methods

speed production and save precious materials

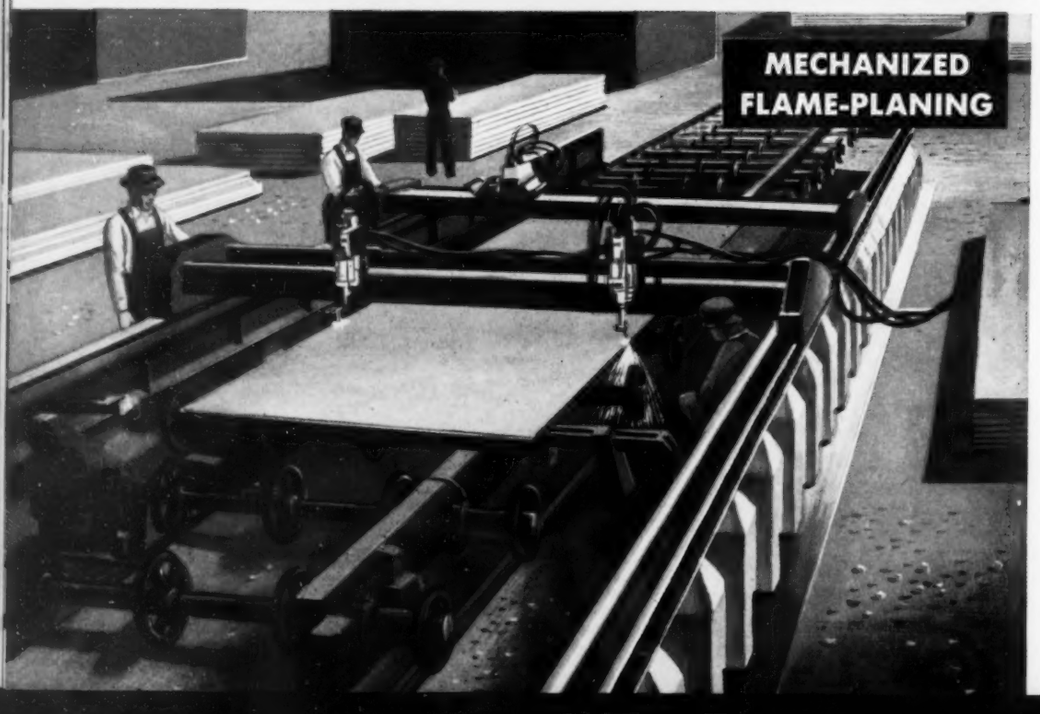
The operations shown here suggest the extent to which Linde's oxy-acetylene metalworking methods have been mechanized. As you give thought to more extensive use of these Linde developments to save time and materials in your own business operations, remember the present need for using every foot of gas only where it will do the most good.



IN MAKING QUALITY STEEL

The removal of surface defects from semifinished steel to produce a higher yield of quality steel once entailed removing the hot steel from the production line . . . allowing it to cool . . . treating it to make surface defects visible . . . laboriously grinding or cutting out these defects . . . and then reheating the steel for further processing.

Today, through use of Linde-developed equipment like that shown here, such time-consuming steps are eliminated. Mechanized batteries of oxy-acetylene blowpipes located right on the roll tables literally "skin" faulty surfaces from the hot steel . . . and higher yields of quality steel are obtained without interruption of production.



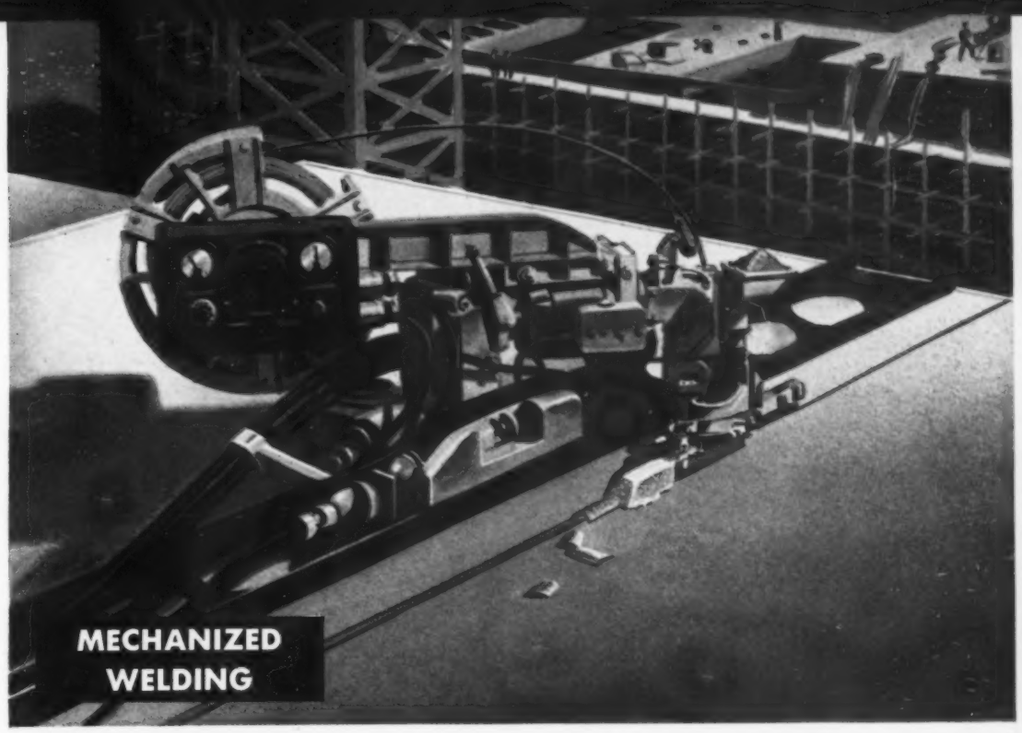
IN PREPARING FOR WELDING

Building a ship is essentially a job of steel "carpentry" . . . a job of cutting quantities of steel plate, structural members, pipe, and other steel shapes to fit . . . then joining them into one huge structure. In the job of *cutting*, oxy-acetylene equipment is effecting important savings, both in time and in materials. The oxy-acetylene cutting flame slices through steel in straight lines, circles, or irregular shapes. It does work that otherwise would require massive machines.

Linde engineering skill has helped adapt this "knife that never dulls" to high-speed work like the flame-planing shown here. In one operation, and with only fractional horsepower required, plate edges are trimmed to exact size and beveled like this for welding.

IN FABRICATING STEEL INTO SHIPS

The Victory Fleet of today is almost entirely welded — because welding is faster . . . saves as much as 20 per cent in steel . . . and because welded ships can carry more cargo, ton for ton. And on America's shipways today an amazing machine is being used to unite steel plates without noise, fuss, sparks, or visible arc . . . by Unionmelt electric welding. This process joins steel plates as much as 20 times faster than any other similarly applicable method! And it produces uniformly strong and ductile welds. The process is automatic. Together with the oxy-acetylene cutting flames that prepare plate edges for welding . . . it has helped to speed the fabrication of ships to its present remarkable rate.



THESE APPLICATIONS ARE IMPORTANT TOO

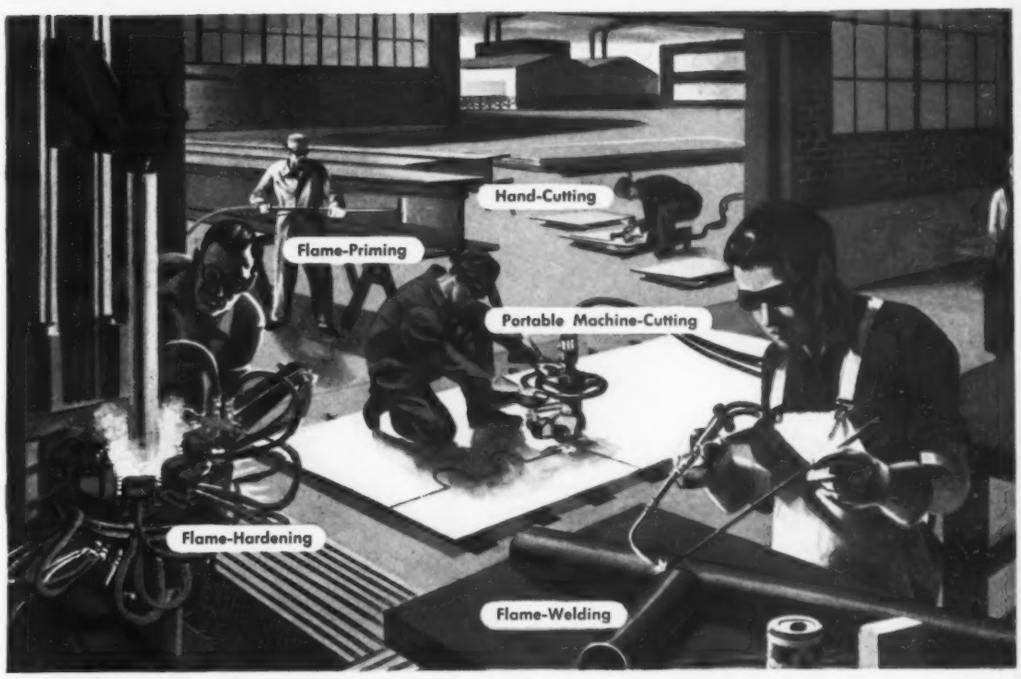
Hand-Cutting—The use of hand-cutting ranges from cutting scrap to severing the final bond to send the ship down the ways.

Portable Machine-Cutting — Lightweight flame-cutting machines produce steel shapes right on the job.

Flame-Hardening—Oxy-acetylene flame-hardening imparts a hard, wear-resistant case to steel and iron parts to make them last longer.

Flame-Welding — By oxy-acetylene welding, broken parts can be repaired . . . worn parts rebuilt . . . leakproof piping systems fabricated.

Flame-Priming—This process removes loose scale, rust, and moisture from steel structures prior to painting.



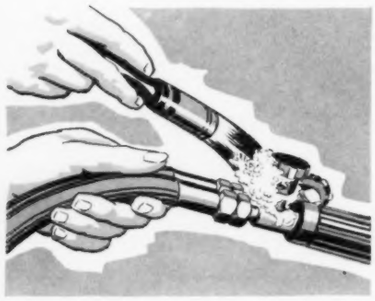
QUANTITY OXYGEN FOR QUANTITY USES

The demand of mass-production industries for oxygen is great. The development of Driox liquid oxygen has made it possible for these important industries to be supplied with oxygen shipped in bulk . . . as a liquid . . . in tank cars and tank trucks. As needed, the liquid oxygen is automatically processed to form gaseous oxygen at a predetermined pressure. This is distributed through pipe lines to operating stations where oxygen is used.

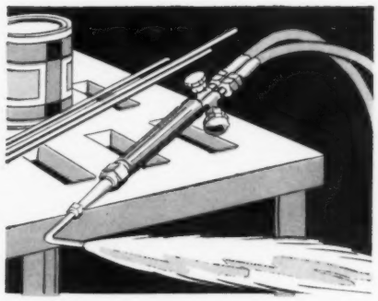
Please turn the page for conservation suggestions.

Here are suggestions to prevent waste of Oxygen and Acetylene in your plant

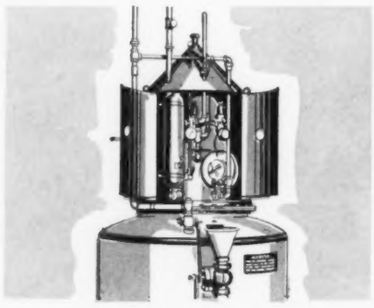
Centralize Oxy-Acetylene Work whenever possible. Concentrate welding, cutting, and other flame processes in as few departments as conditions permit. If this is done, cylinder turnover is speeded, handling is reduced, less apparatus and repair parts are needed, and waste of oxygen is more readily checked.



Check for Leaks. Make sure by frequent testing and prompt repair that no oxygen or acetylene is being lost through leaks in pipe lines, hose, connections, and other apparatus. An authorized inspector should conduct scheduled check-ups and keep track of the operation of each piece of apparatus on an inspection chart.



Eliminate Wasteful Practices. See that blowpipes are turned off when they are not in use. Use recommended pressures and nozzle sizes—not higher pressures or larger nozzles than are necessary. Be sure that cylinder valves are turned off immediately when operators have finished a job.



Convert to Generators. Consult your Linde service engineer to see if you should convert to an acetylene generator instead of using cylinders. A good generator, operated according to the manufacturer's instructions, should function efficiently indefinitely, saving you money and assuring your gas supply.

Recondition Damaged Equipment. Keep blowpipes, nozzles, regulators, and other apparatus in good repair. Some plants have floor inspectors that check equipment while in use and replace damaged apparatus on the spot. Apparatus in good condition helps to conserve gas and to get better results.

Use This Handbook. Give every operator a copy of the "Handbook for the Welding and Cutting Operator." It tells the do's and don't's of apparatus maintenance and provides tables of operating data for the operator to fill in on each piece of apparatus he uses. Send for as many booklets as you need.

Maritime "M" Award
for Outstanding
Production Achievement

The Linde Air Products Company

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

The words "Linde," "Driox," and "Unionmelt" are trade-marks.

BUY UNITED STATES WAR BONDS AND STAMPS

The WEAN ENGINEERING COMPANY, Inc. • WARREN, OHIO

SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

- HEAVY PLATE LEVELLERS
- HI-SPEED SHEET AND TIN MILL SHEAR LINES
- ELECTROLYTIC & BONDERIZING TIN PLATE EQUIPMENT
- WILSON TUBE ANNEALING FURNACES
- WEAN VACUUM CUP SHEET AND PLATE LIFTERS
- CONTINUOUS STRIP PICKLING, SLITTING, SIDE TRIMMING, AND RECOILING LINES

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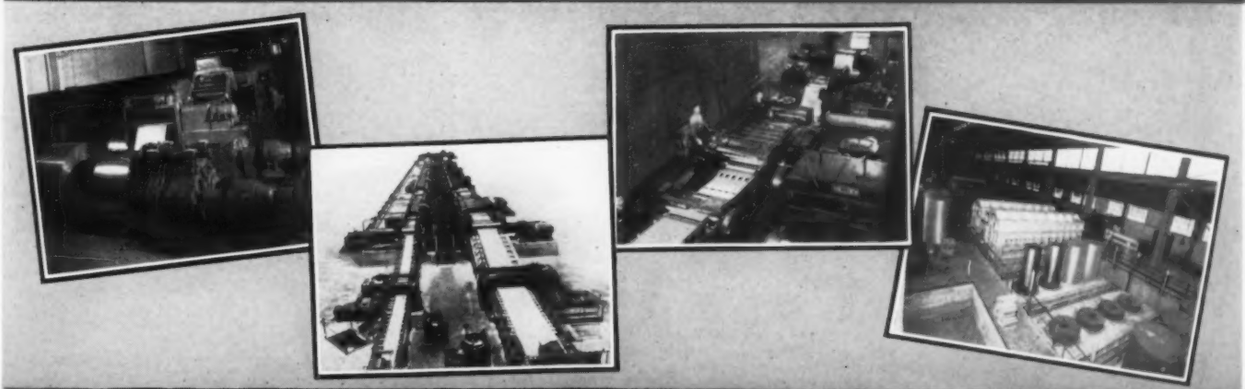
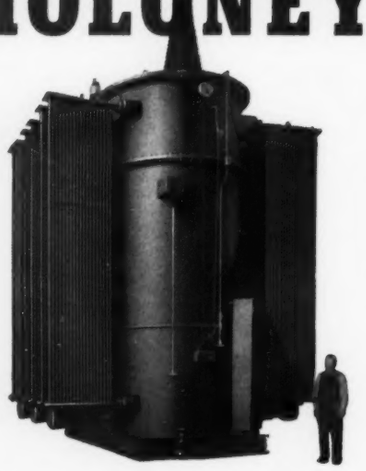
THE WEAN ENGINEERING CO. OF CANADA, LTD.
HAMILTON, ONT.

Subsidiary Company
THE BRODEN CONSTRUCTION CO.
CLEVELAND, OHIO

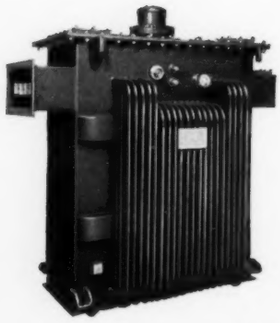


★ ★ SPECIAL MACHINERY for WAR PURPOSES ★ ★

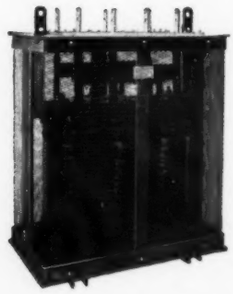
MOLONEY TRANSFORMERS



Moloney Power Transformer. Transformer pictured above is rated 25,000 Kva, 161,000Y to 13,200 volts. These transformers can be supplied in any capacity or voltage desired.



Moloney Askarel (non-inflammable liquid cooled) Transformer. For indoor installation at load centers without the use of fire-proof vaults. Available in all Kva and voltage ratings.



Moloney Air-Cooled Transformer with Class B insulation. For indoor installation at load centers without the use of fire-proof vaults. Available in voltages up to 13,800 volts and in capacities of 150 Kva and larger.

One of these MOLONEY transformers will meet your requirements . . .

Moloney manufactures transformers for all types of installations. If transformers of standard design do not fill your needs, our experienced engineering staff can design transformers which will exactly fit your requirements.

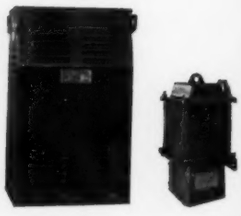
Disconnect switches, oil-fused cutouts, terminal boxes with potheads, forced-air-cooling, secondary air circuit breakers and many other features can be supplied on Moloney transformers.

Quick shipment can be effected whether the transformers are of standard or special design. Your inquiries will be given prompt attention.

MOLONEY ELECTRIC COMPANY
ST. LOUIS, U. S. A.

Moloney Conventiona. Distribution Transformer, oil-cooled, for outdoor pole or platform mounting. Sizes 1½ Kva to 500 Kva. Voltages up to 66,000 volts. Illustration typical of sizes 75 and 100 Kva, 7200 to 120/240 volts.

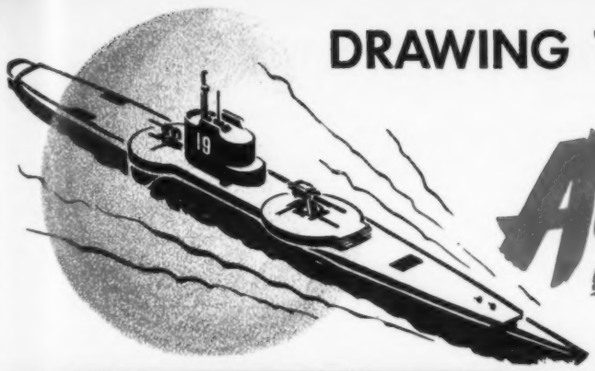
Moloney Completely Self-Protected Transformer, oil-cooled, equipped with built-in lightning and secondary overload protection. Sizes 1½ to 50 Kva. Voltages 2400 to 13,800 volts. Illustration typical of sizes 1½ to 25 Kva, 7200 to 120/240 volts.



Moloney General Purpose Air-Cooled Transformers with Class A insulation. For industrial use to serve lighting and small power loads. Left illustration typical of sizes 15 to 50 Kva. Right illustration typical of sizes 1 Kva to 10 Kva. Voltages 600, 480 or 240 to 120/240 volts.

Moloney
Transformers
for every purpose

- Power Transformers
- Unit Substations
- Conventional Distribution Transformers
- Completely Self-Protected (CSP) Transformers
- Load Center Transformers
- Askarel (non-inflammable liquid) Cooled Transformers
- Air-cooled (Class A and Class B insulated) Transformers
- Constant Current Street Lighting Transformers
- Vault Type Transformers
- Submersible Type Transformers
- Furnace Transformers
- Switchboard Transformers
- Industrial Transformers
- Network Transformers

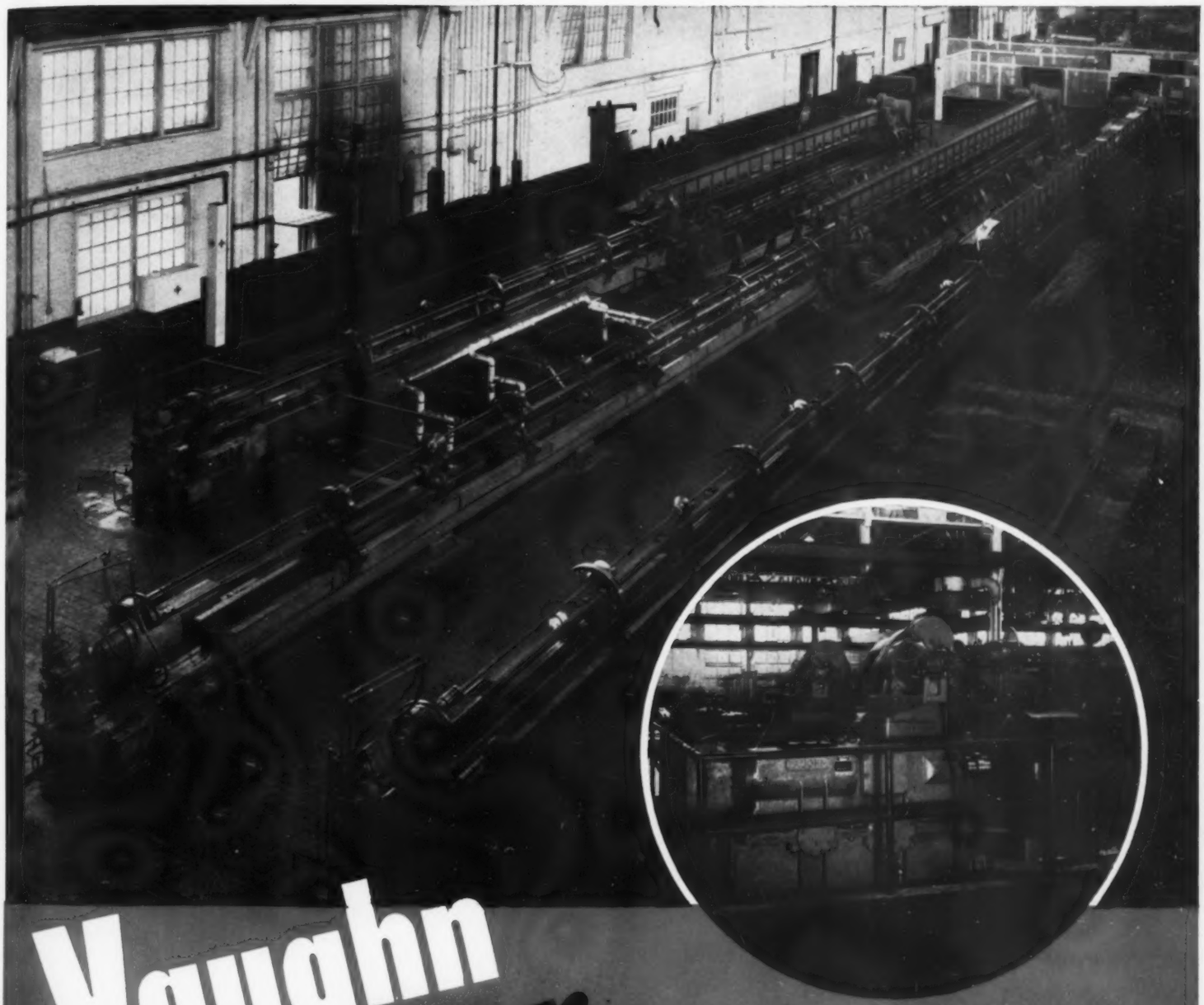


DRAWING THE ESSENTIAL

ALLOY TUBING

FOR MARINE REQUIREMENTS...

FOR ALLIED VICTORY!



Vaughn DRAW BENCHES

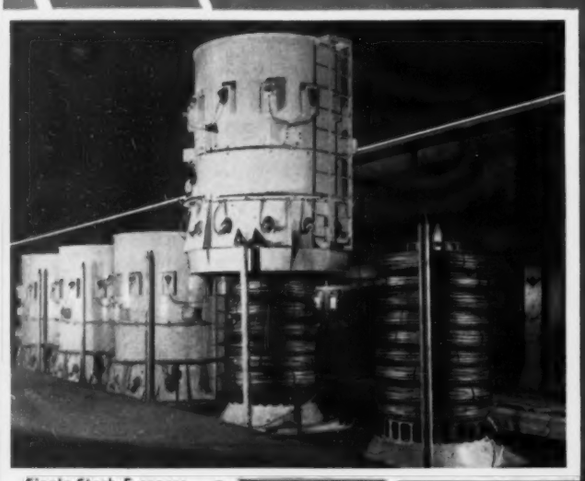
In the plant of a major fabricator, these Vaughn Draw Benches are producing a continuous flow of vitally-needed copper alloy condenser tubing. Engineering soundness and horsesense, plus careful and intelligent manufacturing, provide the answer for successful installations like those shown.

THE VAUGHN MACHINERY COMPANY

CUYAHOGA FALLS, OHIO, U. S. A.

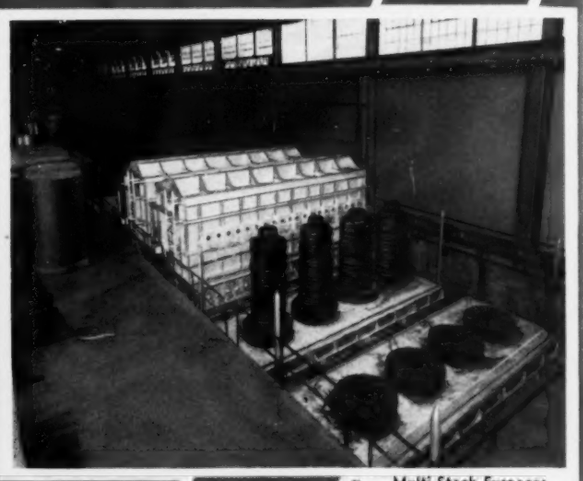
COMPLETE COLD DRAWING EQUIPMENT: Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys

ANNEALING FURNACES *for* ROD & MERCHANT MILL PRODUCTS



Single Stack Furnaces for Rod Coils

• The Wilson Annealing Unit is covered by Patents Numbers 1952402 2068477 2078356 2081612 2089843 and other patents pending.



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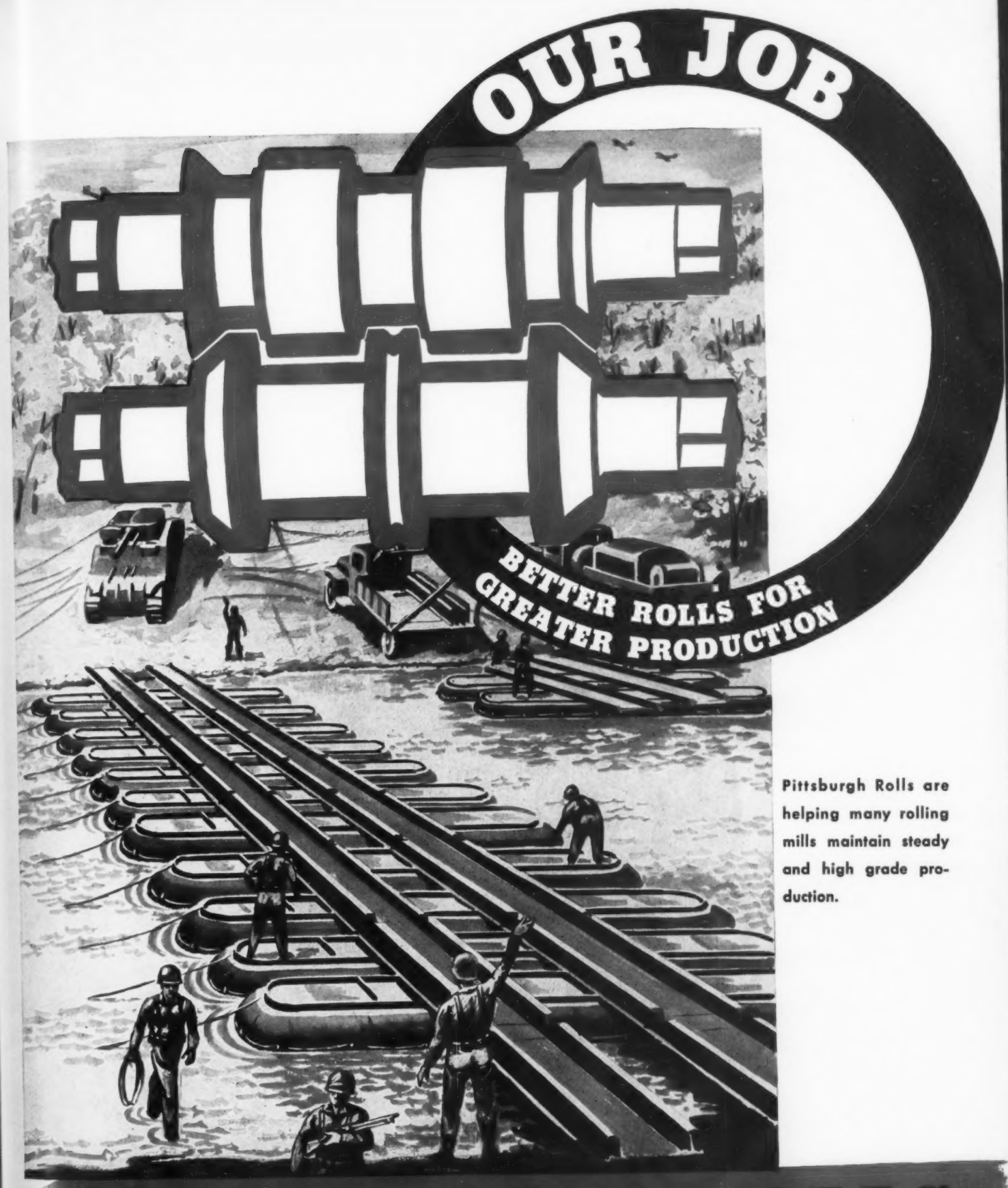

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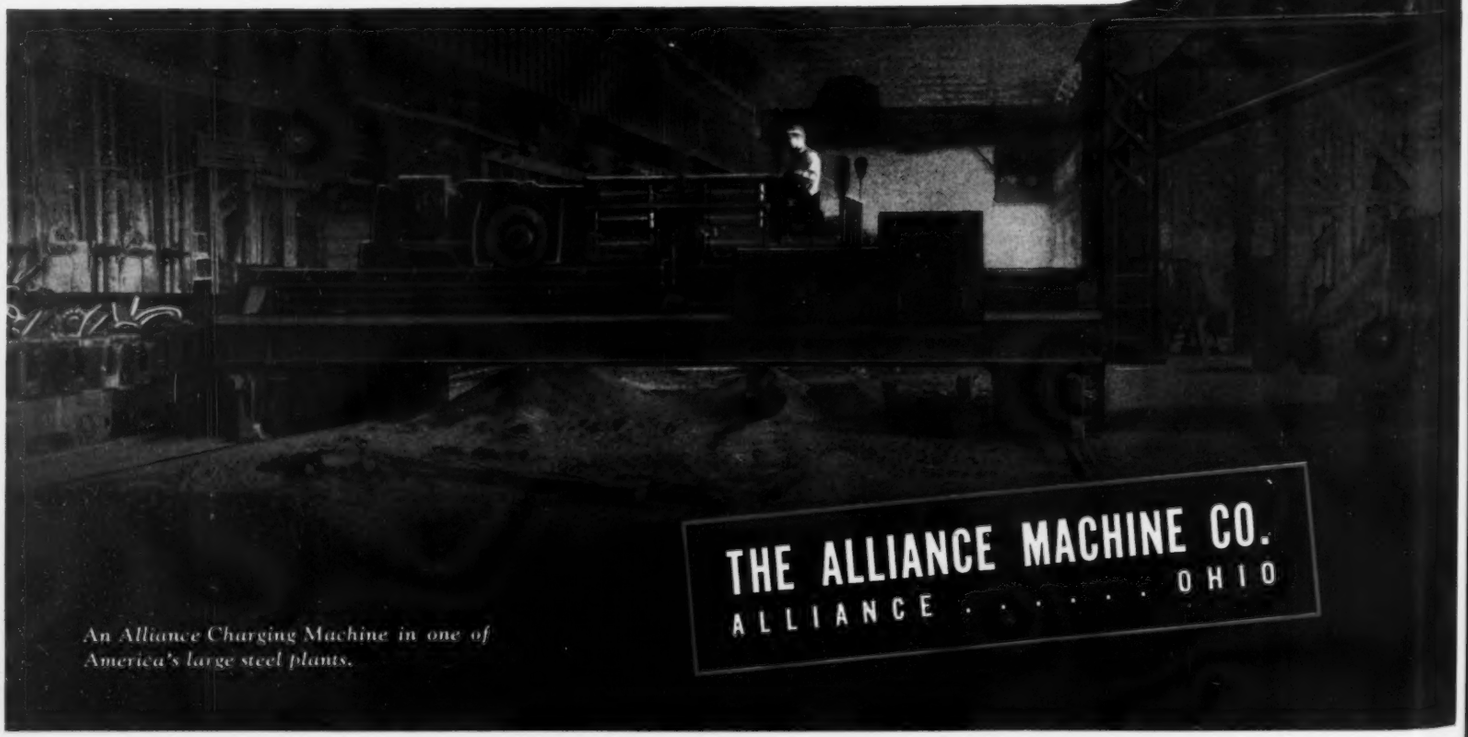

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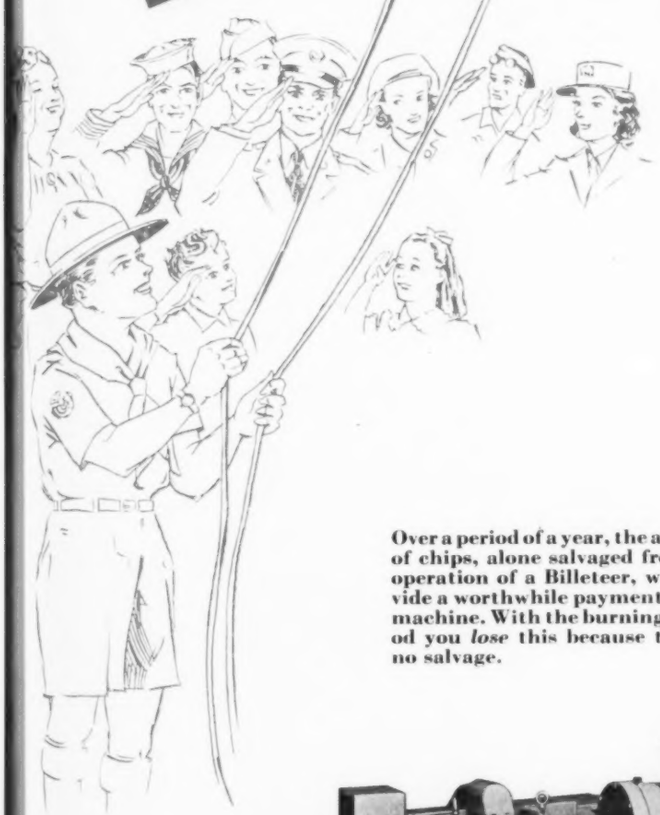

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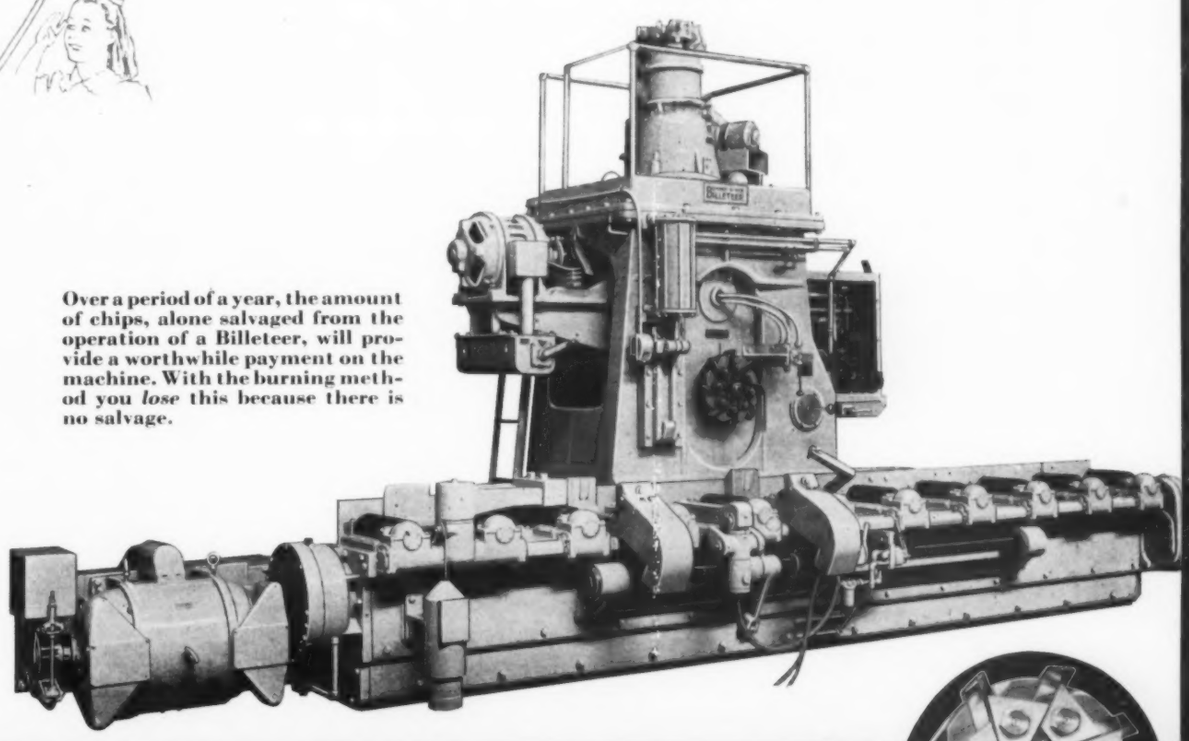

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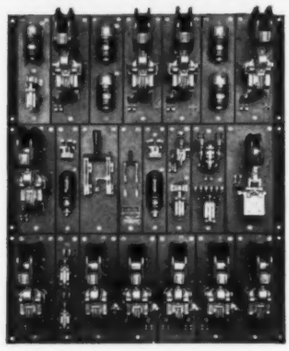

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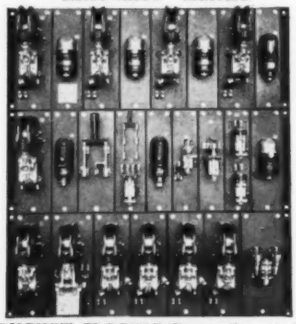

Typical BUCKET-CLOSING Controller of the reversing-plugging, dynamic braking type for Hulett Unloader

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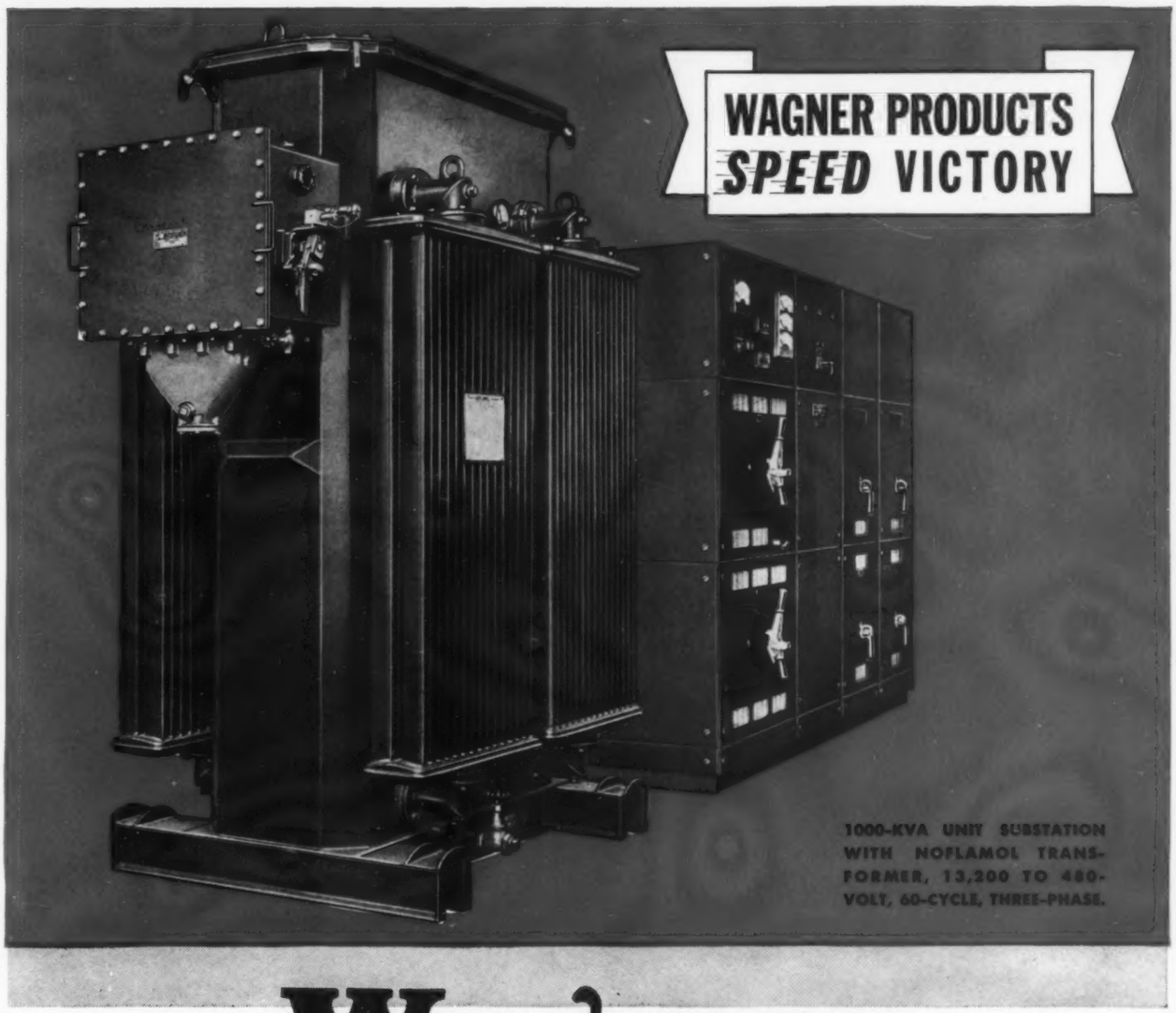

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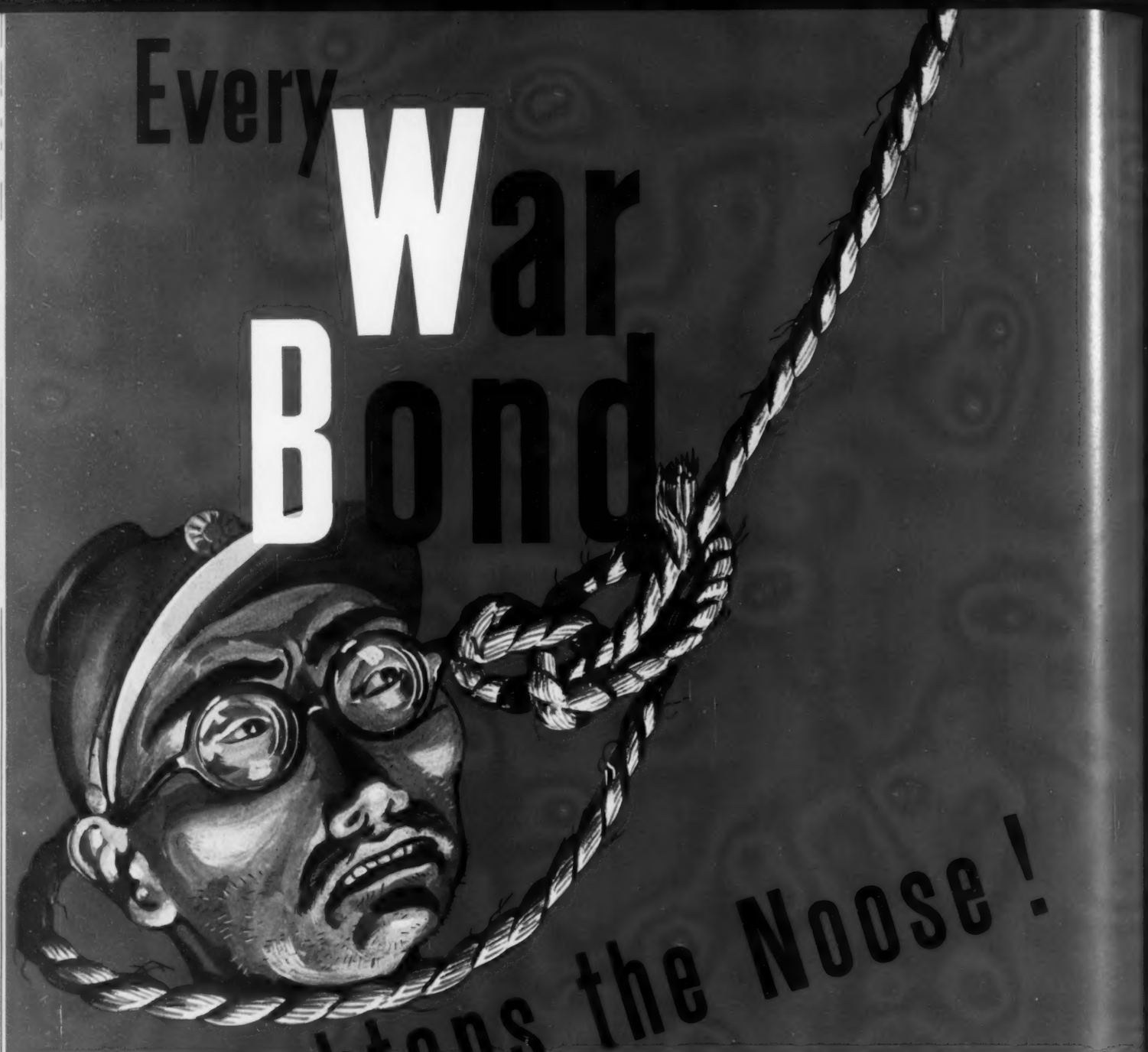

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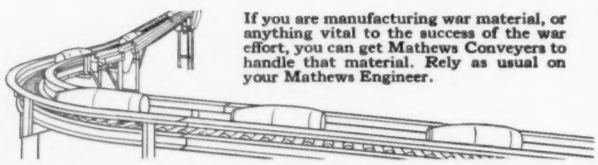

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IRON AND STEEL ENGINEER

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Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS

Entered as second-class matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879
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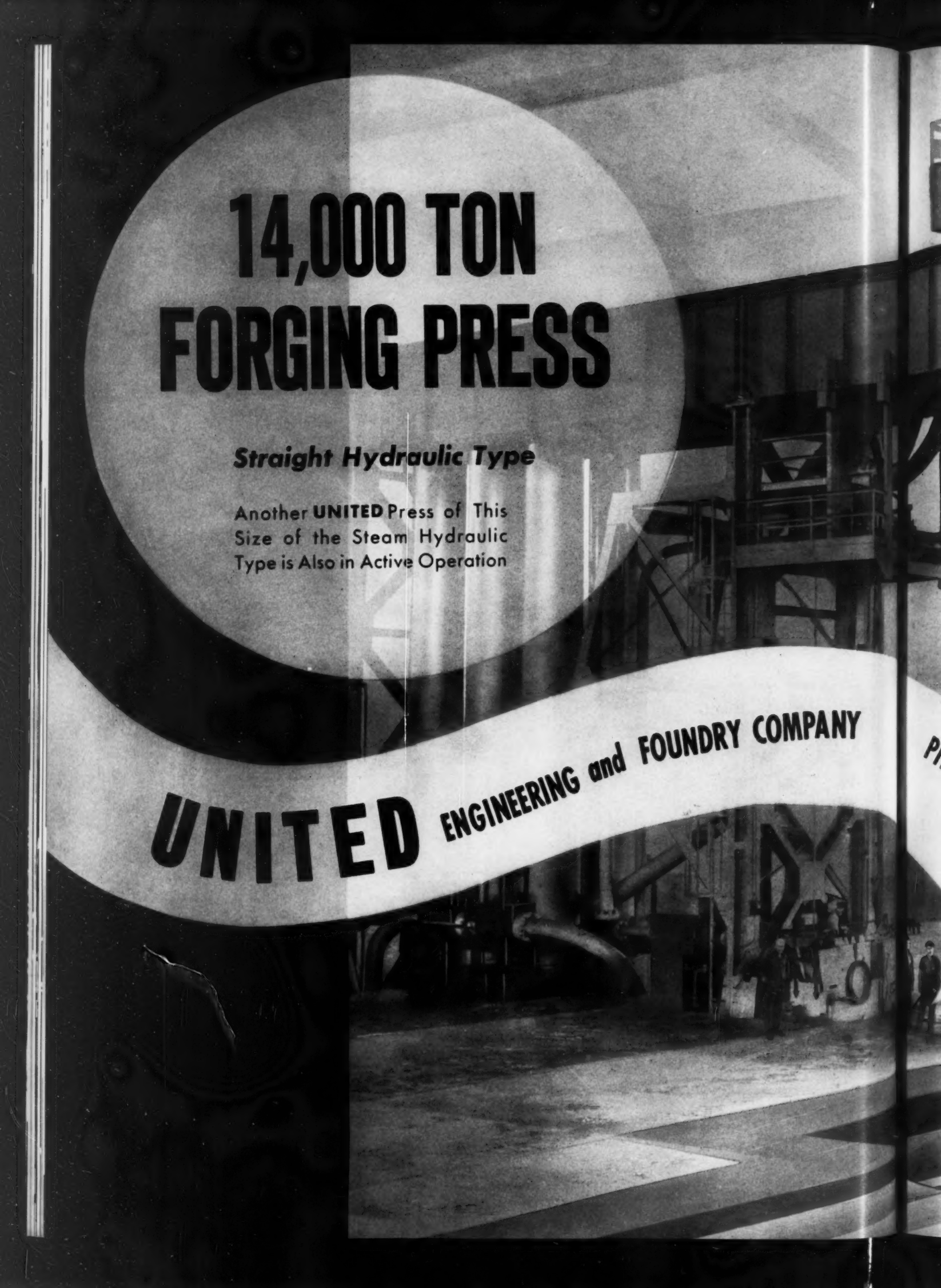
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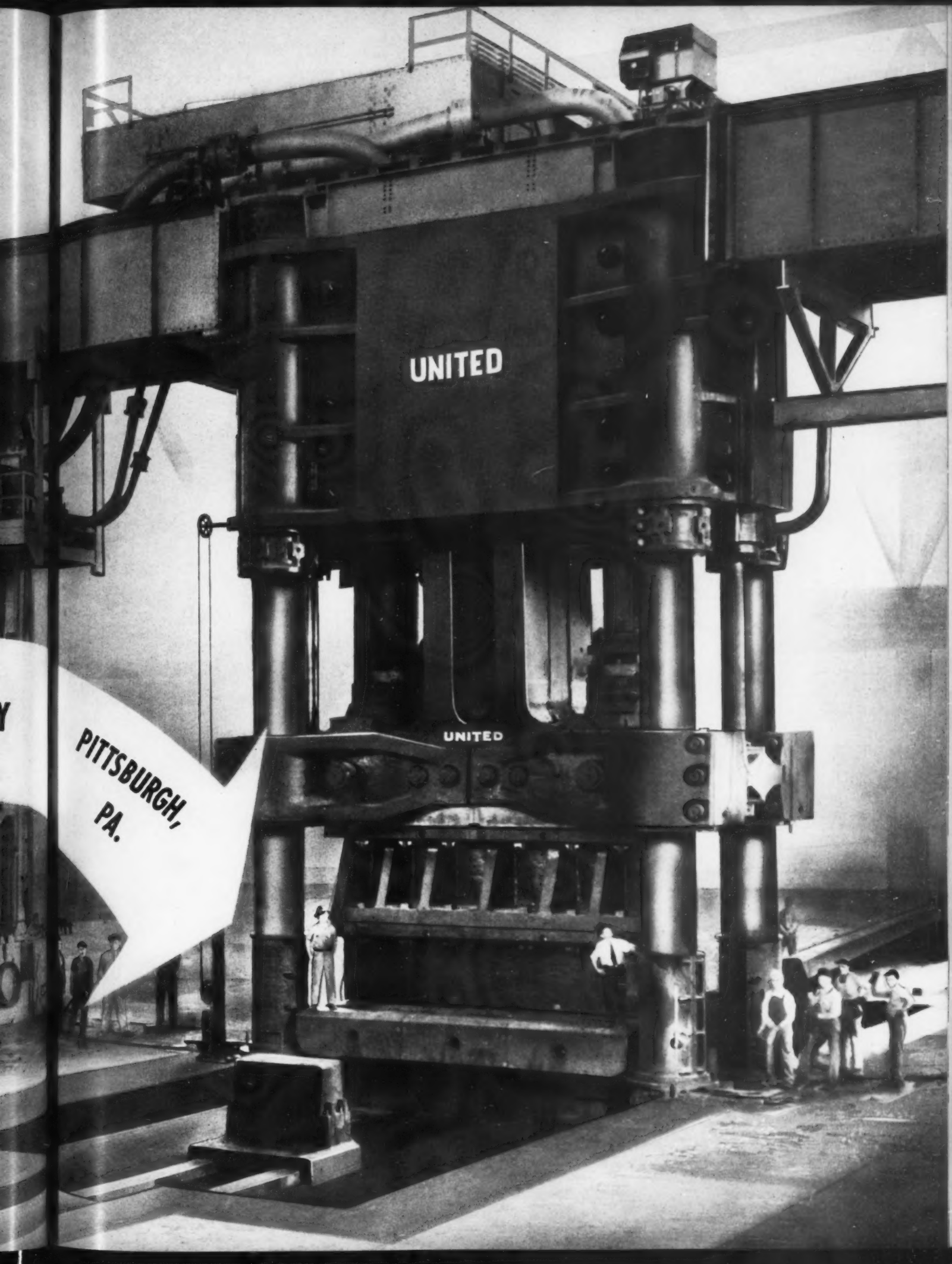
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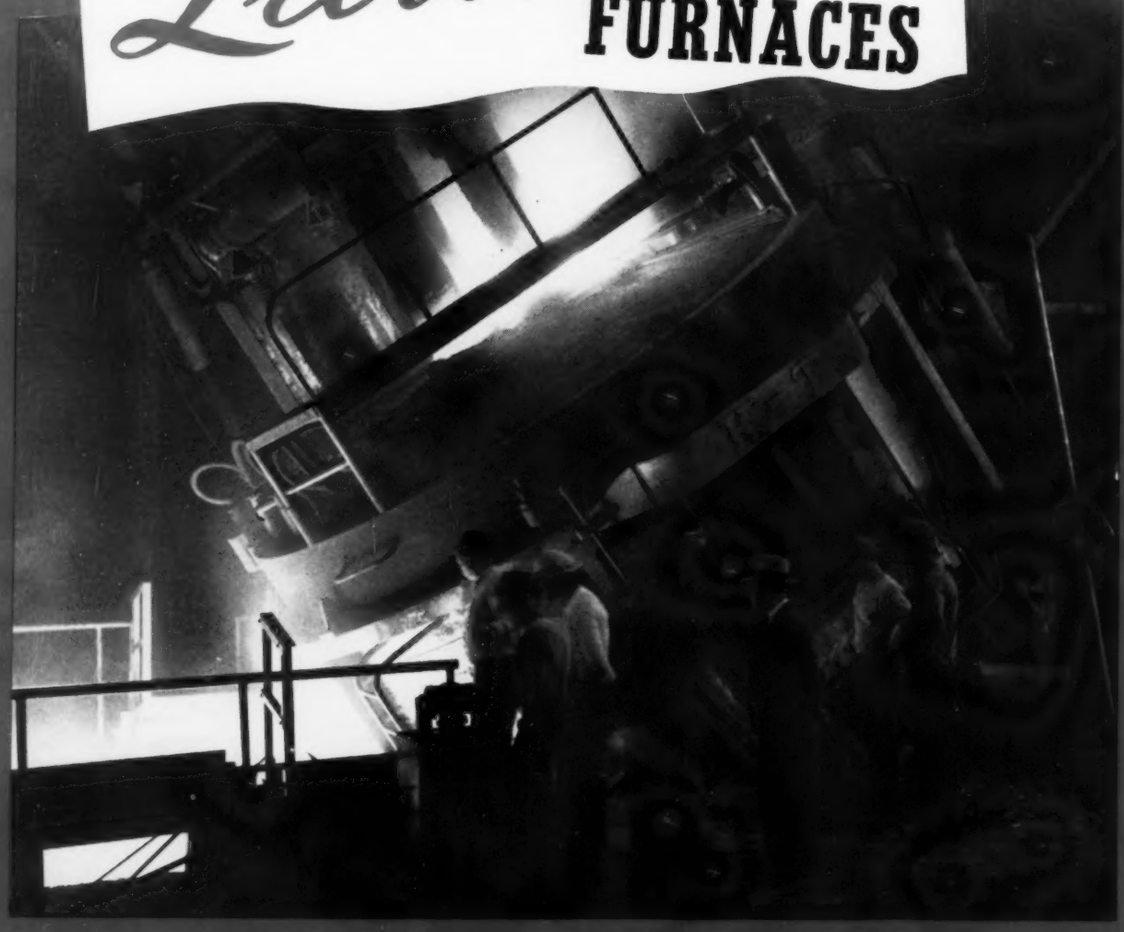

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Maintenance IN WARTIME

. . . . at present, steel plant maintenance is plagued with problems of manpower, spare part deliveries, substitutions, etc. . . . . this paper sets forth methods used in Wheeling Steel Corporation in meeting some of these problems . . . .

by T. R. Moxley

GENERAL MASTER MECHANIC

WHEELING STEEL CORPORATION

STEUBENVILLE, OHIO

▲AS a preface to my remarks, I would like to say that this is a subject that can be discussed to great advantage and I want to make clear that what I have to say is only the experience of one plant. I know little or nothing of the difficulties other plants have been confronted with, or what has been done to overcome such difficulties.

Everyone has been confronted with the serious problem of priorities, the shortage of materials, and the restrictions under which we have been forced to work, due to the various alphabetical departments handing down different rules with which we have to abide. It is not a matter of whether we want to do it; it is a matter of having to do it, and that is what is necessary if we are to attain the goal which we hope will come soon — winning this war. That of course places us in a position where we cannot just sit down and write a letter saying we want a worm gear. So we have had to resort to methods of our own, which cannot be expected to give as good results as a manufacturer might obtain, where he is set up to do a certain thing. Nevertheless we must keep the mills running.

In the beginning, one of the greatest difficulties we have had to overcome is the employment of personnel. Everyone, like ourselves, have had men taken away from our plants and inducted into the armed forces. A great many of them have been our very best men. We have no control over that. We try to be patriotic citizens and not ask for industrial deferments any more than necessary. Therefore we have been faced with the problem of replacing a personnel that has been called to the armed forces, which, in an electrical department or mechanical department, in which skilled men are necessary, has not always been the easiest thing to do. However, in order to accomplish as near as possible the replacement of this skilled labor of which we have been deprived, we made a very thorough study of our whole mechanical department. I refer to those men who are employed out in the plant in the millwright gangs and in other shops, particularly as it applies in the machine shop, because you cannot make a machinist in a couple of months; in fact, we do not try to make machinists, we make machine operators. Therefore we scrutinized our department for what we considered the best prospective material in the repair gangs and took those men into the machine shops, in which we had provided an instructor who was formerly a foreman, a very capable man. We trained some men to be lathe operators, planer operators, milling machine operators, etc., and I am happy to state that of all such men we trained, everyone proved to be capable of becoming a machine operator with the exception of one. It is easier to take a novice into a millwright gang and employ him there as a helper and gradually teach him the fundamentals of maintaining machinery than it is to take him into a machine shop and train him to be a machine operator. Therefore we have been rather successful in replacing machine men by men from the various repair gangs. In our boiler shops we take two green men and place them with two experienced men in order to make fairly competent structural iron workers. We do the same with welders, and by applying this principle we have been able to maintain our mechanical organization sufficiently to keep the plant in good condition and operating 100 per cent.

Presented before A. I. S. E. Pittsburgh District Section Meeting, April 12, 1943

With reference to the controlled materials plan, we just recently have received another order that we cannot spend any more money in 1943 than we did in 1942 for materials, which means of course that we, as supervisors and heads of departments, must be more diligent in the allocation and application of material today than we have been before. We cannot have over a 60 days' supply of merchant iron or structural steel on hand. There are times when we place an order with the necessary priority which cannot be delivered within 60 days; therefore we must be more economical in the use of this material.

Not so long ago we were informed if we needed anti-friction bearings for delivery before July, we must place the order by the 31st of January; and if we wanted anti-friction bearings by the end of December, we must have the order in by the first of March. Still we are not supposed to carry over sixty days' supply. That is rather confusing; nevertheless, that is the order and we must abide by it.

In our own plant, where we have our own foundry, we must furnish a regular purchase requisition through our priorities department for the use of castings in our own plant; also we must make application by the 5th day of this month for the necessary alloys that we contemplate using in the manufacture of bronze, or other copper bearing metals we will be making next month. In order to make the proper predictions as to what our needs are going to be and still stay within the limits of the law, you must be well acquainted with what previous requirements have been.

At Steubenville we make practically all of our own castings, both steel, iron and bronze. We find it rather difficult today to make castings, especially alloys, of a quality that we would like to make, due to the limitations on alloy materials such as tin and copper. Therefore we have had to make a very thorough study of what we can do in order to meet the circumstances and still stay within the limitations of what we are confronted with. We cannot make babbitt any more that contains more than 9 per cent tin. That does not make a very good babbitt, especially for heavy loads. So we developed what we call a high lead mixture and have been successful with this material in replacing babbitt where we needed a babbitt or a bearing metal that would be superior to 9 per cent tin material. We tried this material out in a set of pinion bearings, and also in some drive bearings for the main drive in one of our mills and it worked out very well. It is a high lead material having 71½ per cent lead, copper 6 per cent, and nickel 1½ per cent. In order to alloy these metals, considerable care must be exercised. You must melt the copper separately from the lead. The idea is to make a homogeneous casting in which the lead will be uniformly distributed in the copper. As each has a different melting point, we first melt the lead and then the copper. Considerable agitation is necessary in order to pour these metals together, and the best way is to pour the liquid metal into a pig and let it solidify before remelting it for pouring into a bearing. This mixture has proved to be a good substitute; in fact, in some cases, better than our standard babbitt.

As I said before, it used to be easy to get anythin g you needed in the line of gears and worms, but it got to the point where we could not get these worms and gears, so we had to resort to our own resources and make core boxes for the teeth. We put cast teeth in them because we do not have facilities for machining these gears. We also fitted up a lathe where we could cut the worms up to 3¾ in. lead; otherwise we would have been shut down because we could not get these fixtures. Also, to cut motor pinions and pinions in coupling drives that we must have, we rigged up milling machines and installed a heat treating department and are getting along very well, and can make up almost anything we need up to four feet in diameter.

Another thing we have done that possibly all of you have done: We water cool the buckstays on our open hearth furnaces. These buckstays are made of heavy steel slabs 5 in. by 15 in. wide. We water cool at the line of the front wall. We cut a section out of a buckstay approximately 52 in. long and about 6 in. deep, and with a scarfing torch we channel that section; then we finish it on a planer and weld it back in, and that has greatly added to the life of our buckstays.

In order to try to add more life and reduce the repairs on crane runway rails, we have gone through an extensive program of welding rail joints on electric cranes. We tried steel and got nowhere. We finally developed a method of welding a crane runway rail joint by bronze welding with an acetylene torch, and we have been to a great degree successful in joining the rails together on a crane runway. We have had some break, but not many, and I think as we go along we won't have much trouble. The rail ends must be perfectly square, in fact, machined if possible, so that you get them joined perfectly tight together. We have been using a bronze welding rod, and welding on the base and flange, but not the ball; in fact, we keep the ball of the rail cool while welding by taking a 3 in. angle turned up inside and applying compressed air; the temperature should not be permitted to exceed 500 degrees. In that way we have been able to maintain the physical properties of the metal, and it is working out very good. We are still not through; we are now working to find a rod whereby we can do it quicker, and if we can get it to the point where we can do it equally with the steel rod, it will take 45 minutes to do one job at a cost of about $12.00.

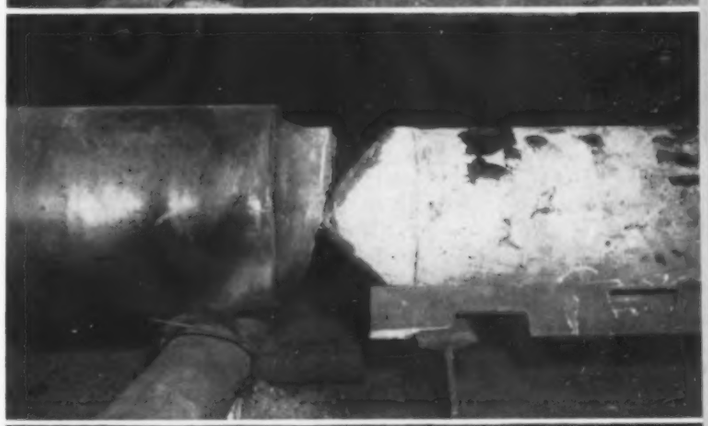
Our strip mill was started up in 1929. It has small diameter work rolls; 18¾ in. is the maximum we can use, and in order to obtain the maximum service from these work rolls, we can only use what we call a 2-row bearing on these rolls. In the smaller diameters of minimum dimensions, the chucks must pass each other; therefore we cannot install a 4-row bearing on our work rolls. However, we have been very successful with bearing costs. The back-up rolls run in roller bearings. We do not have the sleeve type bearings in our back-up rolls. When we first began to operate the mill, we tried keys and everything else to prevent creepage of the inner race on the roll neck. We have a limited tolerance between the bore of this bearing and roll neck of .020 in. We find it is practically impossible to prevent the creepage of that inner race on the roll neck. Tighten it as much as you want, you either break the inner race or you creep. Naturally this causes wear in the bore of the bearing as well as on the neck of the roll. The only answer is lubrication. You can imagine lubricating a .020 in. space is rather difficult when using bearing

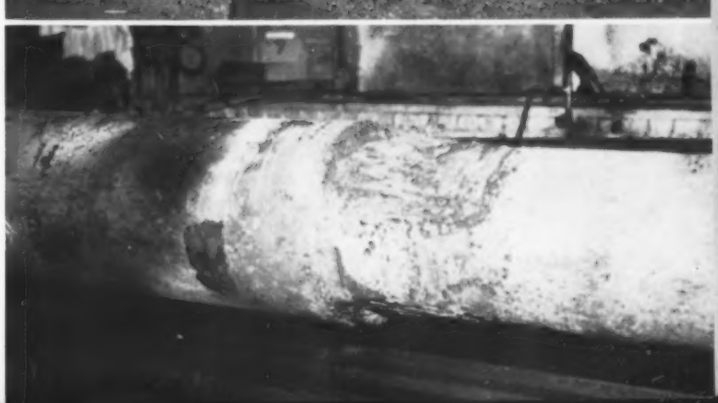
grease. For a long while we were not able to do this successfully, which, of course, meant considerable maintenance on the necks of the rolls as well as on the bearings. However, we now have the necks of these rolls drilled from the end, for a distance which coincides with the location of the bearings, and then other holes bored out to the exact location where the bearings are located on the necks, and we lubricate the necks of these rolls between the neck and inside bore of the bearing by a regular automatic lubricating system. We have a flange bolted on the end of the roll perfectly true with the neck of the roll; in that we have a universal fitting which is connected to the automatic valve which feeds lubricant under pressure. Since we have done that we have practically eliminated the wear on the necks of these rolls and on the inside diameter of the bore of the bearing.

The last six stands of our hot strip mill were lubricated by one automatic lubricating system. This, of course, was a waste of lubricant, because the slower stands were fed just as much grease as the high speed stands. We overcome that by purchasing another automatic system with which we lubricate only the last three stands, the former one lubricating the first three stands. Consequently, the lubricant consumption has been reduced approximately 50 per cent.

I think we have more broken rolls, due to their small diameter, than almost any other plant in the country. We have therefore developed a system of welding roll necks after they have broken off. This is done by casting in the foundry a stub end of ordinary grey iron — it does not have to be a high alloy at all — and welding that neck back on by the acetylene process. We never yet have to scrap a roll until we had gotten the maximum life out of that roll or until it has reached its minimum diameter. The cost of this operation of replacing a neck back on a roll that has been broken runs about $268. Many times we have broken the necks off rolls, where the rolls cost $1400 or $1500, on which we had not obtained $200 in service value out of it; by this repair practice the entire life has been obtained.

Almost everyone is familiar with sleeves on back-up rolls, which is a very costly way of reclaiming back-up rolls, as we have found it. Recently we have developed a system of automatic welding where we have actually welded replacement metal on the body of back-up rolls and obtained a better cost per ton in operation on that roll than we did from the roll as it came to us from the manufacturer. To give you a picture on that, we took a 44 in. by 60 in. back-up roll and put ½ in. diameter





At a cost of about $268 each, Wheeling Steel Corporation repairs broken roll necks by welding.

1. **A cast grey iron stub end is machined ready for welding.**
2. **The broken roll and the stub end are set up ready for welding.**
3. **The welding operation is accomplished by the oxy-acetylene process.**
4. **View of half-completed weld.**
5. **The weld completed, the roll neck is ready for machining.**

on that roll with the automatic welding machine. This automatic welding machine is nothing more than a roll lathe fitted with a 600 ampere welding machine. The roll is heated up to 600 F and put into this lathe. The temperature is maintained all the time the welding process is going on; the roll is then put into a furnace for normalizing at 700 F and cooled down to 100 F before grinding. It costs $300 to put metal on that roll. The original cost before we put that weld on was .00247c a ton. We welded this roll, put it into operation on the 28th day of April, 1942, and to date that roll has produced 385,949 tons with a reduction of .455 in. in diameter at a cost per ton of .00077c. We have found less reduction in grinding, and the cost per ton based on $300 cost is less, which really is not a fair comparison because we still have the roll.

We have experimented with the same thing on a cold mill roll which had many spalls. We cut the spalls out on a roll lathe and then put 1⅜ in. diameter on that roll. We put in 458 pounds of rod with a total cost of about $1300. That roll has been in the mill ever since and so far is doing very well. We are looking forward to having the same success with this roll in the cold mill as with the one in the hot mill; and if we do, we feel the day is not far distant when we can dispense with sleeves on back-up rolls.

The matter of salvage is always with us and greater efforts are being put forth in our plants today in the matter of salvage and conservation of material than heretofore. It used to be that a ¾ in. bolt did not mean anything; to-day, it means a lot. Everything taken out of machines is laid aside and inspected. We recover all that can be recovered and put it back in a suitable place to be used again. If you think it is a small job to educate the personnel of a department to this practice, especially a maintenance department, you are mistaken. They are always in a hurry, more or less prone to be careless, and we are teaching those people to be more economical than they have ever been before. It is a job that must be done continually every day. The same thing is true of sub-foremen; it takes a continual reminding day after day to get results.

We found it difficult to obtain galvanizing pots, and these pots burn out quite frequently. The standard practice was, when a pot burned out, to send it to the open hearth and get a new one. These pots are made of 1½ in. plate, and 66 in. deep. Only the end of the pot will burn, possibly 30 in. back from the end in the fire zone. We found ourselves confronted with the fact that we could not buy pots any more; we had to repair them. These pots have to be made of fire-box steel. With the cooperation of the open hearth department, we were able to roll enough fire-box steel for the repair of these pots. We made some dies in the forge shop where we could bend the plates. We cut out the burnt-out section, weld them in and recover a pot for $238. It costs about $900 to buy it new. I do not think we will ever buy any more new pots, because they only burn out at one end.

More than likely you have been called upon to do everything you can to conserve the use of oxygen and acetylene gases. In our plant, 85 per cent of the oxygen is furnished us through a pipe line from a nearby generating station. We started a drive for the conservation of oxygen. Fortunately we had a man in the mechanical department well qualified for such work, and he was placed on the job of reducing oxygen consumption. We at that time consumed 1,360,000 cu ft of oxygen per month. Through the efforts of this man and the cooperation of all the people in the plant who use oxygen, we have been able to reduce our consumption, without having any affect whatever on the results obtained from the use of oxygen and acetylene, by 302,706 cu ft average per month.

All of you know they spray the run-out table on the strip mill with water. At Steubenville we have to spray this table in larger volume than any other plant I know of, because the distance from our finishing stand is only 92 feet, whereas most of the others are 300 to 350 feet. Therefore we have to flood it hard. The control valve for controlling this water is shut off between operations. We have a valve on the main supply switch operated by an air cylinder. This air cylinder is actuated by a 4-way solenoid air valve and this solenoid valve is operated by a relay. That worked so well we installed these same valves on all stands throughout the mill on roll cooling water. However, in these cases the valves are not operated electrically, but by a foot valve. If there is something wrong at the furnaces and you want to hold the heat in those rolls, you shut off the water. All the operator does is step on it and it shuts off the water.

The biggest problem for all of us is to try to effect that cooperation between management and labor from which we can obtain 100 per cent results. After all, we are in this war against our will; we practically had it forced upon us. The problem in some places seems to be what will happen after it is over; that is not my problem — to me, the important problem is first to win the war.

DISCUSSION

PRESENTED BY

E. W. TREXLER, Superintendent, Mechanical Department, Bethlehem Steel Company, Johnstown, Pennsylvania

W. E. DAVIES, Master Mechanic, Blooming Mill Department, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

H. H. SHAKELY, General Master Mechanic, Hot and Cold Strip Mills, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

JAMES FARRINGTON, Electrical Superintendent, Wheeling Steel Corporation, Steubenville, Ohio

W. H. MANDY, Lubrication Engineer, Texas Company, Pittsburgh, Pennsylvania

J. D. O'ROARK, Electrical Foreman, 10-16-48 In. Strip Mills, Weirton Steel Company, Weirton, West Virginia

E. W. TREXLER: We are interested in the educational plan which Mr. Moxley has told us about. Every mechanical department has that problem. Mr. Moxley selected his men from his millwright gangs. We have selected the men from labor gangs. We put new men

into the labor gangs and in a few weeks ask the foremen to pick out some good workers, put them in the shop and teach them how to operate machine tools. There are many facilities these days to train men. We have drived great benefit from moving picture sound films which are available for that purpose and which are very good.

In salvaging it pays to keep an eye on the open hearth scrap pile. Occasionally you will find a piece in the scrap pile which you do not have and need badly for some job.

W. E. DAVIES: We are welding a coating on 35-45 carbon steel shear knives that costs about one-third less than the alloy knives and we get three times the wear out of these knives against the alloy knives. We throw nothing away and I would like to emphasize what one gentleman said, "to watch your scrap pile." If I had not been watching that lately some 6x6 angles which came in a short time ago would be in the open hearth instead of being in the place they belong.

HOWARD SHAKELY: Do you hesitate to drive a welded work roll from the welded end?

T. R. MOXLEY: No, we drive from either end.

HOWARD SHAKELY: Does welding of a backup roll affect the oil bearing journal?

T. R. MOXLEY: Yes to some extent. The journal must be protected with asbestos covering during the operation and then buffed to remove discoloration and roughness before being placed in operation.

HOWARD SHAKELY: What is the cost of thermit as compared with electric weld?

T. R. MOXLEY: The cost of thermit welding is more; however, no weld is any better than the man who makes it. You must have welders who know what they are doing.

JAMES FARRINGTON: As you know the main square shaft that drives the screw on a stripper is quite expensive. The first one we broke we scrapped; but the next one we broke Mr. Moxley welded. We put it in and it worked very successfully.

T. R. MOXLEY: That is a nickel steel screw. We got a piece of nickel steel that was comparable in composition to the screw itself. We also used a welding rod of similar analysis. However the welding rod was slightly higher in carbon than the nickel steel itself, because when you do an electric welding job, you will pull the carbon down in that job and there is no way to prevent it. With proper normalizing we got a successful weld and the screw is back in operation and will be until it wears out, we think.

W. H. MANDY: What is being done in the way of replacing bronze inserts or all bronze plain roll-neck bearings with babbitt metal? What are the results with regard to the squashing out of the bearing metal?

T. R. MOXLEY: With this metal they are replacing the conventional babbitt type of copper inserts.

W. H. MANDY: With some copper-lead bearings there has been separation of the lead from the copper; what do you attribute this to?

T. R. MOXLEY: As to the cause of that it is hard to answer, other than this: If you do not have the proper mixture and if you don't work fast enough to get the lead and copper properly mixed, you will have segregation. The lead will sweat right out of the copper unless homogeneously mixed.

W. H. MANDY: Before the bearing is put into use?

T. R. MOXLEY: Yes. There is one other thing I want to say along this line of babbitt. You have pinion bearings in the mill. Occasionally they will wear out and there is a lot of babbitt in those bearings. In an ordinary 12 in. diameter neck pinion, it costs about $3,000 for the complete repair job. We do not do that any more, unless the babbitt is badly broken up. When these bearings wear to the extent that they get to be $\frac{3}{32}$ in. loose, you had better get them out of there. One-eighth of an inch will be the limit to which you should allow any mill pinion bearing to wear, especially in a strip mill. When we take those bearings out, if we find they are not broken badly, but merely cracked slightly, we pour babbitt right back into them without melting the babbitt out at all. We have not drained a set of mill pinion bearings for a long time.

J. D. O'ROARK: When we hear what these other companies are doing, it makes some of us feel that we are a little bit behind in this matter of conservation. To my mind, one of the biggest helps in this saving program is to keep equipment inspected and serviced and keep it out of repair shops. That lubrication is very important is quite true; it will save hours in the machine shop and avoid using up critical materials. If a bearing is properly lubricated with the proper lubricant at the proper time, it goes a long way toward avoiding all the undesirable results of neglect and inattention.

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IMO PUMP DIVISION
of the De Laval Steam Turbine Company, Trenton, N. J.

THE *Selection* AND *Care* OF *Wire Rope*

. . . . in spite of its seemingly minor role, wire rope is called upon to handle important and dangerous jobs . . . . care in its application and maintenance is essential . . . .

by J. U. Hoffman

WIRE ROPE DIVISION

BETHLEHEM STEEL COMPANY

WILLIAMSPORT, PENNSYLVANIA

▲ ALTHOUGH wire rope is not of very ancient origin, much of its earlier history is comparatively obscure. Immediately preceding its present widespread use was the clumsy chain hoist, in its various forms. Now and then an antique of this variety may still be seen, although it has more sentimental than actual value.

One of the largest single outlets of wire rope is our steel mills. In view of this, it seems quite reasonable to assume that the development and improvement of wire rope is, in a large measure, a result of its use within the steel industry itself. The wide variety of applications within a large, self-contained steel plant should be interesting and possibly also surprising in scope. Among the most important uses are:

1. Overhead electric cranes. This is the largest classification, and it includes such items as cranes for general uses, for hot metal handling, soaking pits, yard storage, scrap yard, shipping departments, wall cranes, and many others. In most mills this group is serviced by the electrical department, regardless of location, whereas others are usually attended by the mechanical section of their respective departments.
2. Ore bridges, including Huletts and other types of ship and barge unloaders.
3. Coal bridges, coke plant car-hauls and endless railways.
4. Blast furnace skip cars.
5. Rotary car dumpers.
6. Locomotive cranes, both in construction and transportation departments.
7. Freight and passenger elevators in mills and offices.
8. Sling ropes.
9. Miscellaneous small and shorter ropes, too numerous to list.

Wire rope specifications for these purposes should include the following items: (1) Grade or quality of material; (2) Type of construction.

In regard to grade, three principal catalog listings are available. These range from a wire with as low as 0.05 per cent carbon, commonly termed "iron," through "plow steel," up to the top grade "improved plow steel." All these are trade names only, handed down from the early days of the industry. The improved plow steel grade is selected for almost all mill uses, although plow steel may sometimes be substituted in applications of minor importance.

Both grades of plow steel offer the advantage of having been drawn from selected steel rods, ranging from 0.50 to 0.85 per cent carbon, according to the size of the finished wire, and usually in the upper part of the range. A greater care in wire making, such as lower drawing speed and lighter draughts and more frequent patenting, makes the higher carbon wire more resistant to fatigue than the lower grade. This fact must be impressed upon the layman who is unacquainted with the art of wire drawing. Skill and experience are required to arrive at a finished wire product with both high torsional and tensile strength. Every bundle of wire must pass a critical inspection for both of these properties before it is delivered to the rope making department. Definitely defined wire mill procedure and closely controlled practice are strictly adhered to in making these high grade and high quality wires used in the fabrication of the higher grades of rope. A table giving the minimum

Presented before A. I. S. E. Philadelphia District Section Meeting, April 3, 1943.

requirements is set up for each size of wire and the figures are rigidly adhered to.

Improved plow steel has better general wear resistance than plow steel, and the ultimate strength is about 15 per cent higher. This higher strength is an advantage in case of overload, or sudden applications of a load, conditions which may be encountered occasionally, even in the best operating practice. One can scarcely go wrong in specifying this quality for general steel mill work.

Coming to the selection of a rope type, or construction, for a particular job, one is confronted with a more difficult situation, and one which calls for a high degree of experience. Unfortunately, there are no fixed rules or formulas for such a selection, and controversies may occasionally arise from this source. However, long experience has brought about fairly uniform standards for many of the more common applications. More will be said about this later, and the user, if in doubt, is earnestly advised to contact his supplier and have an experienced engineer come and look over his problem.

Rope construction, or type, refers principally to the number and the arrangement of the individual wires going into the fabrication of a rope, or, more correctly stated, into each strand of the rope. It also refers to the direction of twist, both in the wires of the strand, and in the strands of the finished rope. Reference is finally made to the type of center, whether fiber or metal.

Fully 95 per cent of all wire rope is of 6-strand construction. Among the few exceptions are some 8-strand elevator ropes. Here only 6-strand ropes will be discussed. In the making of the individual strands an unlimited number of wire combinations may be used. Each strand is, of course, made separately, but alike.

A rope type is usually designated by the number of wires in each strand, as, for example, a 6x7 rope, which has 6 strands of 7 wires each. In making these strands 6 wires are twisted about a center core wire. Examples of them ore common types are 6x19, 6x21, 6x25, 6x37, 6x41, and many other modifications for special uses. It can readily be seen that as the number of wires increases for a given size rope, the individual wires must be of smaller diameter to fit within the same space. An additional number of wires must therefore be laid around the central wire. Various arrangements of the individual wires may be used. For instance, in an especially popular rope called Seale, the inside wires are particularly small, while the outside wires are larger than usual. This particular type takes care of severe abrasive wear, but

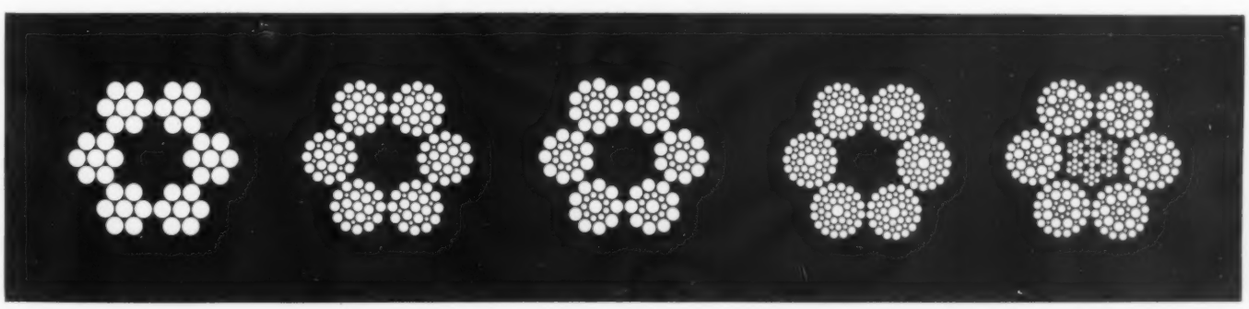
Figure 1 — One of the largest single outlets of wire rope is the steel mills, and much of the development and improvement is a result of its use in the industry.

its flexibility is slightly decreased. Thus we find that the more wires used per strand, the smaller their size, and the more flexible the rope. However, it must not be overlooked that the surface wearing quality diminishes directly as the flexibility increases. This is very important and one of the basic factors governing correct rope application. It is easy to fill one requirement if the other is ignored, but, to properly balance the two, requires the experience of a rope engineer. This reasoning will now be applied to a few actual cases in practice.

The first case considered is such application where severe abrasive action is the chief factor, such as car-hauls, skip hoist ropes, etc. Such equipment has comparatively large drum and sheave diameters. This allows for a flexible, but more rugged type of rope — fewer, but larger size wires. In turn, it also gives longer life in case of severe and unusual surface wear. Thus 6x7 or 6x19 Seale construction might be applied. A 6x37 rope, by way of illustration, would be more flexible but less rugged.

Having mentioned 6x37 rope, it might be well to discuss it further, especially as it happens to be the most popular rope type used in steel mills. In general, its chief application is in overhead crane service. Limited

Figure 2 — Some typical wire rope sections, left to right: 6x7, hemp center; 6x19, type W; 6x19 Seale, hemp center; 6x37 type M, hemp center; 6x37, independent wire rope center.



sheave and drum diameters create the need for flexibility and resistance to bending fatigue. Actual wear is light. These installations are easily lubricated, and, generally speaking, the work itself is easier in nature, especially from the standpoint of wire abrasion, than the average rope job as we find it. Also not to be overlooked is the fact that 6x37 rope handles exceptionally well. It is therefore highly favored by the men who have charge of replacements. It is often difficult for a wire rope engineer to overcome this partiality, a fact worthy of emphasis.

In this connection it may be well to bring up the alternative use of the 6x19 type wire rope for overhead crane service, but limiting it to the smaller sizes, from ¾ in. down. Such applications are not uncommon, especially under present conditions when 6x37 is more difficult to secure due to the greater amount of labor and time required in its manufacture. True, it does not conform so well to recommended sheave diameters as 6x37, yet experience has found a place for it in many applications. Its use is not so radical as many would believe. It is, of course, not to be so recommended in the larger sizes, from ⅞ in. up. Also, the inside reserve strength of 6x37 is admittedly an advantage. A greater proportion of the total metallic area is contained within the inside wires which are not subjected to abrasive surface wear. For this reason especially, on jobs such as hot metal cranes 6x37 construction should be used, regardless of size.

Some more definite mill usages of the 6x19 type will now be taken up. This is by far the most popular type made, and as a general purpose rope, except for overhead cranes, it dominates the field. In fact, broadly speaking, it has a definite place wherever wire rope is used. While the basic term used is often just plain 6x19, it is now manufactured almost entirely with 19 principal wires, plus 6 small filler wires, which, of course, adds up to 6x25. Other of its designations, depending upon the maker, are type "W," type "N," "modified Seale," etc. Its mill uses include ore and coal bridges, locomotive cranes, slings, skips, car dumpers, etc., and also a multitude of general purpose and emergency applications.

So far only ropes with fiber centers have been discussed. It is definitely understood in the industry that fiber centers are assumed unless otherwise specified. In the case of metal centers, single strand centers are seldom used, and the independent wire rope center is universal. As the name indicates, independent wire rope center is simply a small, separate wire rope which replaces the fiber. The two principal advantages are to prevent the rope from crushing on drums of extremely small diameter, and especially, to give greater protection in case of shock loads. It also helps to prevent crushing occurring in multiple layers of overwinding. A secondary benefit is an approximate 10 per cent increase in the ultimate strength of the rope.

For steel mill usage, independent wire rope centers have only limited application. This design is sometimes used to advantage on locomotive cranes. For hot metal cranes its advantage has been overemphasized, as the actual need for core heat protection is not borne out by actual facts. Inspection of discarded fiber ropes will bear out this statement. Even so, its use for this purpose would not deserve any great amount of criticism were it not for the fact that "bird caging" might be experienced in a 6x37 rope with an independent wire rope center. This very flexible 6x37 rope also has excellent elastic properties, and, between the extremes of full load and no load, structural movement takes place. The IWRC rope may not go along evenly with the main rope in this respect, and tight spots may have a tendency to develop. When the load is off, the IWRC

Figure 3 — In the regular lay (left), individual wires of each strand are twisted in one direction, and the six strands are twisted in the opposite direction. In the Lang lay (right) individual wires and finished strands are twisted in the same direction.

will accumulate enough tension at hese places to outpull the main rope and open it up in the form of a so-called bird cage. Shortly, a definite and permanent cage develops. These are, of course, dangerous. One extreme case has come to attention where a rope on a hot metal crane fouled in the sheaves, and the heat froze. Less serious cases are so common that the use of fiber centers has been adopted with entire success by many mills.

Only standard regular lay ropes have been discussed in the foregoing, that is, ropes in which the individual wires of each strand are twisted in one direction and the six strands, in making the finished rope, in the opposite direction. A Lang lay rope is different in the direction of twist. In making a Lang lay rope both the individual wires and the finished strands are twisted in the same direction. By so doing, the arc of contact of each wire is lengthened and a greater wearing area is exposed. However, the general stability of the rope, as a whole,

is lessened. This type of rope works well in some cases where conditions are most favorable, but it has very little mill application. It can work well on skips and endless railways. However, it is best to ask advice before experimenting with this rope.

In recent years there has been an increased demand for preforming of the strands for wire rope. Today preformed wire rope represents a substantial part of the total wire rope output. The chief benefit of preforming is the extra flexibility imparted to the rope by this process. It also helps materially in stabilizing a Lang lay rope. Any grade or construction of rope can be preformed. An extra operation is involved whereby each strand is given a predetermined and fixed helix which corresponds to the lay of the finished rope, this being done just before the strands pass through the final closing die. Preformed rope can be applied to almost any mill installation. It is especially desirable for abnormally small drums and sheaves, and where difficult drum spooling is encountered. An excellent example in this respect is its standardization on winches of mechanized war equipment. Millions of feet are in use for this purpose.

Large quantities of wire rope are used for slings in the average mill, for a great variety of purposes. Consequently, both 6x19 and 6x37 type ropes are in use for this service, in about equal amount. The choice is made chiefly on the shape and contour of the bundle or object handled. Sometimes a personal preference will influence the choice. For some bundles there is a need for tight gripping of an irregular contour, to prevent slippage. In such a case 6x37 is recommended. In other cases, especially where large single objects are being lifted, slippage is less of a factor, and the rope often receives rougher treatment. The preference here would be 6x19. At any rate, the choice between the two constructions is quickly learned through experience, and there is little need of going any further into the subject. However, there is the question of the initial cost of the two ropes, and this difference may have some bearing. The first cost of 6x37 is about 20 per cent higher than that of 6x19, grade for grade. The cost may also have to be considered in other cases discussed where a choice of either rope could be made.

After having selected the correct type the proper care of the rope must be considered, with emphasis on the following points:

1. Care in installation
2. Lubrication during operation
3. Attention to sheave grooves
4. Inspection

It is common knowledge that a rope may be ruined before it has made its first lift. Kinking during installation is the most common cause. The expression "once a kink, always a kink" has almost become axiomatic. Care and common sense are the simple requisites. Much mill rope is delivered in coils and careful handling of these is usually even more important than of the larger stock reels. The coil itself should be rolled. While a definite kink may not necessarily develop by doing otherwise, there is almost sure to be a certain amount of twist put in the rope. While in many cases this is imperceptible to the installation men, this twist develops and builds up decidedly as the rope operates. Twisting of fall blocks is a good example. This too becomes

Figure 4 — Wire rope slings are widely used for a great variety of purposes. The type of rope chosen depends on shape and contour of the object handled.

permanent in most cases. Unshackling to allow the twist to run out is the best remedy, but even this procedure is not always a cure. Repetitions during the life of a rope are usually necessary.

In the case of longer lengths taken from reels, the rope should be strung out on the ground, in multiple loops if necessary. Twisting is also common here, and the far end should be loose to allow any twist or incipient kink to run out. On the larger and more important jobs it is often advisable and perfectly feasible to give the rope several preliminary runs before putting it into actual operation under full load. Generally speaking, it may be said that in the case of wire rope trouble, on the whole, the probable cause should be carefully weighed by the user before the product is condemned. Wire rope is a material greatly abused and slandered.

For the average inside mill crane rope the best lubricant is good engine oil, or one of the lightest grades of special rope lubricant as produced by most of the larger oil companies. Twice-a-month lubrication is probably sufficient. Almost all wire rope today is laid up, when manufactured, with ample internal grease, a fact well worth emphasis. Some few cases of mill service require dry rope, such as in highly finished sheet departments. Care must be taken to order dry rope in such cases, as it must be specially made. This would also apply for rope ordered for sling stock exclusively. For ropes used in the yards, a heavier-body lubricant is necessary. Practically all of it should be of a consistency requiring heating prior to application. All major oil companies put out an excellent product for this extensive use, and they can best specify the particular product needed. For larger and more important uses, the grade should be changed with the extremes of seasonal temperatures, if an especially good job is desired.

More careful attention should be given to sheave grooves, particularly when a new rope is installed. It pays to use the best hardened steel sheaves. Even then a long-lived rope will tend to cut when worn down to a smaller diameter. All wire rope has a certain normal oversize when new and the effects of a badly worn

A Good Schedule for Lifting Loads Safely

ROPE DIAMETERS IN INCHES	CHAIN				WIRE ROPE				MANILA ROPE				SISAL ROPE			
	90°	60°	45°	30°	90°	60°	45°	30°	90°	60°	45°	30°	90°	60°	45°	30°
⅜	1800	1550	1250	900	2050	1750	1450	1000	200	170	140	100	100	85	70	50
½	3000	2600	2100	1500	3700	3200	2600	1850	340	290	240	170	170	145	120	85
⅝	4600	4000	3250	2300	5600	4850	3950	2800	560	480	400	280	280	240	200	140
¾	6750	5850	4800	3400	8050	7000	5700	4000	690	600	490	350	345	300	245	175
⅞	9350	8100	6600	4670	10800	9350	7650	5400	980	850	690	490	480	425	345	245
1	12400	10700	8750	6200	14000	12100	9900	7000	1150	1000	810	580	575	500	405	290
1⅛	15600	13500	11000	7800	17600	15200	12400	8800	1550	1350	1100	780	780	675	550	390
1¼	19200	16600	13600	9600	22000	19000	15500	11000	1750	1500	1250	880	875	750	625	440
1⅜	23000	19900	16300	11500	27200	23600	19200	13600	2240	1950	1600	1100	1120	975	800	550
1½	27200	23600	19200	13600	32000	27700	22600	16000	2450	2100	1750	1200	1225	1050	875	600
1¾	35000	30300	24700	17500	43200	37400	30500	21600	3550	3100	2500	1800	1775	1550	1250	900
2	44400	38500	31400	22200	52000	45000	36800	26000	4200	3650	2950	2100	2100	1825	1475	1050
2½	65600	60300	49200	39800	85600	75100	60500	42800	6100	5300	4300	3050	3050	2650	2150	1525
3									8550	7400	6050	4300	4275	3700	3025	2150

groove can readily be pictured. It is far better to have an oversized groove than a groove which pinches the rope. Wire rope has a surprising ability to hold its shape without complete support.

Periodic inspection of all rope should be made; for more important and hazardous jobs as often as once a week, or even every day, as for example on ladle cranes. The number of broken wires found in a rope is an indication of its condition, but it is really impossible to set up a fixed rule to govern the removal of a rope on this basis. The nature of the operation, the type of rope, the age of the rope, wear in diameter, original safety factor, as well as personal opinion all carry weight. Most men use the general rule of playing safe without unnecessary waste, and surprisingly few accidents occur when this practice is followed. In ladle crane usage it is common practice to allot a fixed time service for a set of ropes and to remove them regardless of outside appearance. These ropes are usually of such size and construction that they can very nicely be used elsewhere in less hazardous work.

HOW TO MAKE YOUR MAGNET LAST LONGER

One thing about an experienced operator—his magnet lasts years longer and gives far less trouble. That's important when steel and copper (the materials magnets are made of), and the manpower to repair magnets are so scarce.

HERE ARE 8 MAINTENANCE RULES THE EXPERIENCED OPERATOR FOLLOWS:

DON'T USE MAGNET AS SKULL-CRACKER

Many magnets don't wear out. They are broken—by careless handling. Don't drop a magnet to break up heavy pieces of scrap or to loosen a frozen ingot. *Use it only for lifting.*

DON'T USE MAGNET AS A BATTERING RAM

You may break a pole shoe, a terminal box, damage the windings or rupture the insulation inside the magnet. *Use the magnet only for lifting.*

KEEP MAGNET DRY

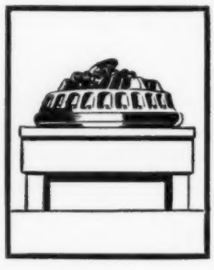
Do not cool magnet with water; also protect in storage. The average magnet left on the ground absorbs moisture which causes short circuits and cripples its lifting power. Always store magnets where it is dry... on a low platform or on blocks.

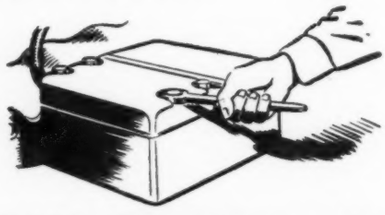
SET YOUR MAGNET DOWN EASY

A 65-inch magnet costs $3600. Repairs to broken magnets have cost up to $2000... and use up precious time, repair parts and manpower. *EASE* your magnet down on to the pile.

KEEP BOLTS TIGHT

And replace broken bolts. Helps to keep moisture out, protects pole shoe against mechanical shock and helps to keep lifting power at maximum.





KEEP TERMINAL BOX CLOSED

Keeps moisture away from terminals and protects them against breakage. If cover is lost, get a new one.

GREASE CHAIN LINKS AND KEEP 'EM GREASED

Chain links constantly rub against each other causing friction and wear. Keep the links greased, keep friction down and your chains will last much longer thus saving critical materials.

WHEN HANDLING HOT MATERIALS

Watch magnet temperature carefully and switch to spare magnet to avoid overheating.

REPORT OPERATING TROUBLES TO MAINTENANCE FOREMAN AT ONCE

COURTESY, CUTLER-HAMMER, INC.

RECONDITIONING *Flood-Submerged* ELECTRICAL *Apparatus*

. . . . during the past decade, nature has, at various times and in various localities, conspired to bring flood waters tumbling into our steel plants . . . . from these incidents has come a wealth of experience in reconditioning equipment which has been submerged . . . .

by L. V. Black

SUPERINTENDENT, ELECTRICAL DEPARTMENT

BETHLEHEM STEEL COMPANY

BETHLEHEM, PENNSYLVANIA

▲ THE Bethlehem Plant of Bethlehem Steel Company, located along the Lehigh River close to its junction with the Delaware River, was completely shut down due to high waters on May 23, 1942.

Heavy rains throughout the valley caused the river level to rise 3.15 ft on May 22nd, but as it maintained the elevation of 214.75 ft for 16 hours no one was alarmed. Trouble is not experienced until a level of 222 ft is reached.

At 10 P.M. the water started to rise at an alarming rate. With an average rise of 20 inches per hour the maximum height of 233.08 ft was reached 11 hours later, at 9 A.M., May 23rd. The total rise was 21.5 ft and the greatest rise in any one hour was 34 inches. Water began entering the plant at 6 A.M. both through sewer manholes and by overflowing the river banks. The drop in the water level was almost as rapid as the rise. By 1:30 P.M. practically all surface water had drained off.

Large mill and pump drive motors, electric treating furnaces, electric arc furnaces, etc., were shut down as early as 1:45 A.M. in order to take advantage of all possible precautionary measures against submersion, such as plugging drain holes or sewer connections, building dykes, or disconnecting and raising motors. However, as the water rose to a height never expected, and so rapidly that the workmen were caught in the flood before much work could be done, most of this preliminary work failed to accomplish the protection desired.

Presented before A. I. S. E. Philadelphia District Section Meeting, April 3, 1943

Substations, generators, boiler houses, and power tie lines to the outside power company were kept operating as long as possible, and were shut down only when the water was within an inch of the top of the oil switch tanks, or just before it reached the windings of the machines. It must be stated that a lot of confidence had to be placed in the electrical and mechanical performance of control circuits and switchgear operating mechanisms. Important units were maintained in service to the last possible moment, at which time some of the operating controls, relays, and oil-switch solenoids were under water.

Real activity in shutting down started about 4:00 A.M. All mills were down by 4:20 A.M.; all plant generation by 5:25 A.M.; substations by 6:45 A.M.; and all incoming power supply sources by 7:50 A.M. As this cut off all possibility of power to auxiliaries of boiler houses, a complete plant shutdown resulted.

A quick survey showed that the first relief on power would be from the power company's 110 kv circuit. As soon as the water started to subside, men working in four feet of water disconnected all controls connected to the switchgear of a 12,000 kva 110,000/6900 volt transformer bank. After manually closing the necessary switches at the transformer station, the line and transformers were energized through the power company's switches and relay protection some 25 miles away. This was at 1:26 P.M., or 5½ hr after the complete shutdown.

This arrangement allowed parts of the plant not affected by high water to be put back into operation, and also provided power and light for rehabilitation

purposes. A second bank of transformers was put in service at 4:25 P.M. on May 24th; the 15,000 kw plant turbo generator at 3:25 P.M. on May 25th; the 20,000 kw, 60 to 25 cycle frequency changer supply from the power company at 8:20 P.M. on May 26th; the first gas engine driven generator on June 3rd.

Due to water conditions which will be described later, all remaining gas-driven generators required a week to ten days for additional reconditioning. Shops, mills, and other equipment were put back in service as soon as the reconditioning of component parts could be accomplished. Concentration of effort and attention was given to the units which are of first importance to plant operation, or to vital delivery schedules. Most of the plant was back in operation by May 26th, although normal operation of the entire plant was not achieved until June 6th.

Before the flood had reached its height the seriousness of the far-reaching destruction was apparent Urgent calls went out for help; for skilled and unskilled labor; carbide and battery flood lights; portable gasoline driven pumps, compressors, and power generators; shovels, trucks, boots and tarpaulins; electric strip heaters, infra-red lamp banks and meggers; pumping engines from fire companies for emptying pits and cellars; lime and disinfectants to prevent sickness and epidemics; services for electric repair shops; skilled mechanics for overhauling complicated machine tools, etc. The plant was also canvassed for all types of labor, ovens, furnaces, heaters, etc. for drying electrical equipment.

The response was very gratifying. Help was offered and given from all sources. Men, materials, equipment, etc. were received in a short time; in fact some truckloads arrived while parts of the plant were still under water.

REHABILITATION

The flood affected most of the plant, submerging some sections to a depth of 11 ft and flooding 1166 general purpose motors, 12 mill drive motors, 10 motor generator sets, 26 large drive motors for compressors, pumps, etc., 7 generators, and 1 rotary converter transformer, a total of 1222 units. Of these, 1182 were low voltage, 39 were 6600 volts, and one a mill drive motor for the 35-inch reversing blooming mill, composed of two 600 volt d-c motors mechanically connected to form a unit.

In order to meet the demands for quick rehabilitation the electrical department set up the following schedule:

(1) General supervision, subject to call 24 hr per day.
   (a) Superintendent and assistant.
   (b) Foreman of power houses and transmission system.
   (c) Supervisor of shops, expediter and foreman of outside repairs.

(2) Supervision of working forces.
   Two 12 hr shifts, each shift comprising:
   (a) General — 1 coordinator.
   (b) Shop — 1 foreman.
   (c) Construction — 1 foreman.
   (d) Power — 4 leaders.
   (e) Maintenance — 4 leaders and 4 engineers.

(3) Working forces.
   All available men were scheduled on two 12 hr shifts as long as they could be used to advantage, after which they were put on three 8 hr shifts.
   (a) First nine days: 288 men on day shift; 170 men on night shift.
   (b) Next seven days: 262 men on day shift; 92 men on middle shift; 98 men on night shift.

In removing the flooded equipment for reconditioning, the units were marked with indestructible tags bearing sufficient identification to designate shop and exact location. All wires were also tagged on each side of the disconnecting lugs before any connection was broken. Maintenance men, with the aid of mill or shop operating forces, removed all electrical and mechanical connections. A loading crew lifted the motors from their foundations to trucks or cars. The motors were then washed thoroughly with a stream of clean water to remove mud and silt and delivered to some drying location.

At these locations, bearing reservoirs were thoroughly cleaned, end shields were taken from enclosed motors and brushes from holders, oils and grease were removed from commutators and windings, and where necessary, armatures were removed from motor frames.

Large units such as mill-drive motors, generators, air and gas-compressor motors, motor-generator sets, etc., which were too cumbersome to move were first cleaned thoroughly, a drying oven was built over them, and they were dried out in place.

Reconditioning motors up to 200 hp was performed with the following equipment:

(a) Three 14 ft by 50 ft gas-fired car-bottom furnaces with automatic temperature control, at 275 F — 538 motors, 4 portable welding sets, 26 welding transformers.

(b) Two 5 ft by 20 ft gas-fired, car-bottom annealing furnaces, and two covered railroad cars equipped with blower-type electric heaters, without automatic temperature control — 254 motors.

(c) Electric heat treatment furnaces — 22 motors.

(d) Foundry core ovens — 19 motors.

(e) Electrical department repair shops, standard baking ovens and infra-red lamp banks — 84 motors.

(f) Strip heaters — A number of open-type motors having only a few inches of water on the windings were dried in place with strip heaters. Controls and conduits were covered with tarpaulins, and strip heaters placed to the best advantage.

(g) Outside electrical service shops:
   Shop A — 83 motors, 11 portable welding sets, 12 welding transformers.
   Shop B — 87 motors.
   Shop C — 64 motors.

Before the last of the motors were removed for drying, those first reconditioned were returned for installation.

Close contact was maintained with the management, to keep informed which mill, shop, or unit should be given preference according to production and shipping requirements. By replacing some motors with a few unflooded spares, or by swapping some of the others, units were put on operating schedules very quickly.

On the whole, reconditioning of the flooded equipment did not differ from the standard practice familiar

to all. Some of the more special problems were as follows:

All scale cars delivering materials to the blast furnace skips had been completely submerged. The few spare field coils and armatures in stock could not possibly meet the demand of the occasion. Field coils and armatures placed in baking ovens for 40 hr at 225 F did not test clear on ground tests. The market was canvassed for new field coils while three infra-red lamp banks were set up for drying the armatures. After 3 hr baking, they gave a clear test on 250 volts, and stood up in service.

The 6600 volt, 3000 kva gas engine driven generators which had been half submerged were cleaned, covered with tarpaulins, and dried for three days by means of large, motor-driven unit steam heaters. In addition, portable welding sets were used to supply full field current to the d-c coils. Following this the generators were uncovered and dried by the standard short circuit method. However, short-circuited coils caused the loss of two generators shortly after they had been put in service. For this reason, and in the light of past experience, we believe that wherever possible the quicker and more thorough method of drying such stators is by passing a full-load current at low voltage through the entire winding, covering the machine with tarpaulins to conserve the heat.

After the first generator had been put back on load, with several others on the drying cycle, ground indications on the ungrounded exciter system were traced to the field coils of the previously cleared generator fields. Investigations proved that water was still trapped between the winding and the pole pieces, and 120 flooded field coils had to be removed.

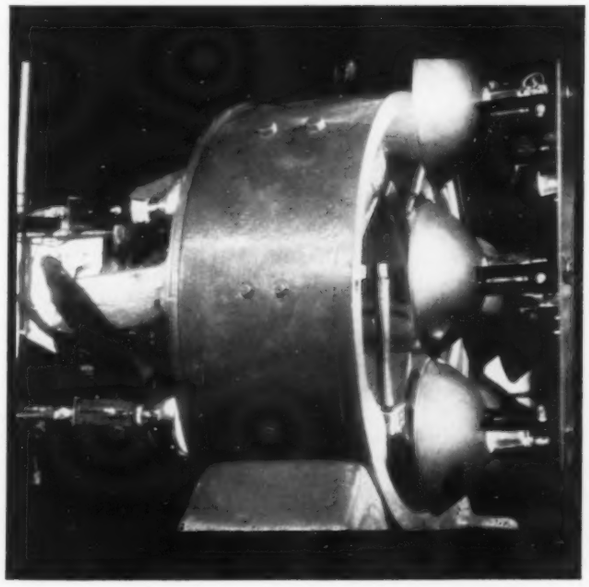
With only one crane in the building to serve maintenance, operations, and clean-up, a difficult problem was presented. Steps were immediately taken to build a temporary timber structure over one generator, to support a motor-driven hoist. A 5-ton truck-type crane was also used. As a result work could be carried out on three generators at one time, together with all other reconditioning work.

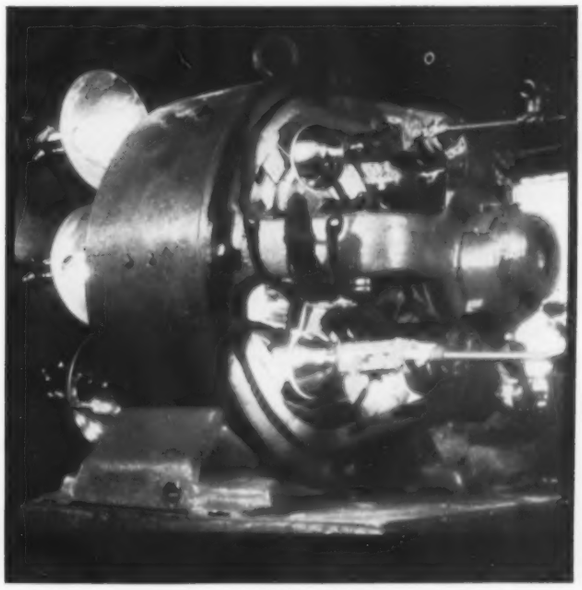
Here again field coils placed in a drying oven at 275 F for 42 hr still showed grounding, whereas coils put under infra-red lamps gave a clear test in five hours. (Weight of coil with pole piece, 800 lb.)

Several 6600-volt, mill-type motors were cleaned with a good commercial grade of safety solvent. The drying proved to be an exceptionally long and discouraging process. After being put in service for a short time, one motor stator failed several times due to shorted coils. On each occasion one or two coils were cut out of the circuit. Another motor had to be rewound. Examination of the coils showed that the safety solvent acted as a vehicle and carried dirt and oil through the minute cracks or laps in the insulation. The outer layers of insulation were so swollen that the coils were destroyed while being removed from the slots. No trouble was experienced with high-voltage windings cleaned with carbon tetrachloride. The d-c reversing-mill motor for the 35-inch blooming mill had been almost half submerged. After cleaning, a low-voltage current from a gasoline-driven welding set was passed through the constant and variable-voltage fields. A house was built over the motor and heated by motor-driven unit steam heaters. In addition steam drying coils consisting of 12 loops of $\frac{3}{8}$ in. thin-walled copper tubing were wound around each commutator. The coils were covered with felt to insure good and even heating.

The motor was considered sufficiently dry after a week of drying and was put to work. After $6\frac{1}{2}$ days of

These photographs show the application of infra-red lamp banks for drying out motor coils, as used at Lukens Steel Company. Equipment of this type may be used following general repair work, as well as in drying out flooded equipment.





continuous operation, smoke was noticed filtering from a cable pit. Tests revealed that the armature and cables were heavily grounded.

It was believed that water trapped under the commutator had scattered during operation. The extent of coverage could not be told. The motor was again enclosed, steam unit heaters were applied, and in place of the steam coils, infra-red lamps were distributed uniformly around the commutator. After half an hour of lamp heating, an oily and watery fluid began to ooze from between the bars at the locations touched by the crest of the flood. Other spots of clear moisture were also noticed.

This method of drying was continued for nine days. Periodically the armature was rotated about one-quarter turn. About one-third of the V-ring bolts were loosened. Evidence of moisture and varnish being forced out around the bolts indicated the presence of water. An air syphon was connected to draw air or moisture out of the opening beneath the commutator.

Five times during the drying period the voltmeter used for testing indicated almost a solid ground. This ground continued for periods ranging from 5 min to 14 hr. After each case, however, a better insulation resistance reading was obtained. When on the ninth day an almost solid ground developed and remained unchanged for fifteen hours, it was decided that further drying was useless. The motor was assembled, and after all other circuits were tested clear of grounds, it was put in service. Satisfactory operation resulted, and the grounded condition has greatly improved with operation. On July 10th, the ground resistance was 395,000 ohms, on December 7th, 1,280,000 ohms.

SUMMARY

Power houses and motor rooms present a sorry sight after a flood, with water and mud all over everything. The first step is to clean all equipment thoroughly with water under moderate pressure, and, at the same time develop a general plan for drying. A standard record card for reconditioning flooded electrical equipment should also be made available for all plants subjected to flood waters.

The second step is to dry out the equipment. The best method for any specific case must be determined by local conditions, available equipment, etc. Among the various methods employed in reconditioning equipment in the May 23rd flood at the Bethlehem plant, the following gave the best results:

1. Water under commutators of miscellaneous motors — Remove one-half of the V-ring bolts before baking.
2. Water under commutators of drive motors — It is recommended that all manufacturers of this type of equipment should definitely provide some means for forcing hot, dry air between the commutator and the commutator barrel, or for connecting a vacuum pump to this compartment. It would accomplish results in hours that otherwise require days of baking.
3. Badly soaked field or solenoid coils — Slit the outside protective insulation in several places before baking.
4. Water trapped between field coils and pole pieces — Remove fields for rapid drying, or loosen field poles so that water can run out and moisture be driven out by heat.
5. Swelling of insulation and internal shorts of high voltage motors, when cleaned with safety solvent — It was found that the use of carbon tetrachloride produced much better results.
6. Meggers used for ground testing — Although megger readings are commonly accepted as an indication of moisture and insulation resistance, during a drying cycle, experience has shown that even with a perfect drying curve, coils have shorted internally. Upon examination water was found between turns or layers of copper.
7. Slowness of baking ovens for flood emergencies — Several banks of infra-red lamps used for baking produced rapid and satisfactory results.
8. Painting — It is recommended that electrical equipment should not be painted or dipped in insulating varnishes immediately after flood drying. As all moisture cannot be driven off quickly the varnish will seal the moisture in the coils, and shorted coils will result. Equipment should be operated for several months to make sure that all moisture is driven off before they are painted.

An ounce of prevention is better than a pound of cure. Having learned by bitter experience, Bethlehem Steel Company has now installed a tell-tale system interlocking with the company's civil defense system. This arrangement is designed to give ample warning in the event of destructive floods similar to that recently experienced.

This flood experience has also resulted in decision to elevate certain transformers, oil circuit breakers, and miscellaneous equipment; to thoroughly water-proof drive-motor pit foundations, and to build a dyke around the large blooming mill drive motor.

Permanent high water marks, such as welded beads, bolts inserted in walls, or stenciled lines and sings on buildings, have been established throughout the plant to guide future engineering design and installation problems.

DISCUSSION

PRESENTED BY

G. J. WALZ, Assistant Electrical Superintendent, Bethlehem Steel Company, Steelton, Pennsylvania

H. E. ODENATH, Coordinator, U. S. Engineers Department, Philadelphia, Pennsylvania

C. L. EICHENBERG, Experimental Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania

R. E. MILLER, General Foreman, Electrical Department, Bethlehem Steel Company, Sparrows Point, Maryland

M. J. CONWAY, Special Engineer, Lukens Steel Company, Coatesville, Pennsylvania

W. H. BURR, Superintendent Electrical Department, Lukens Steel Company, Coatesville, Pennsylvania

G. J. WALZ: To Mr. Black very properly belongs the credit for having done a really magnificent threefold job — first, by so ably rehabilitating the submerged electrical equipment of his plant after the disastrous flood of May 1942, under the pressure of the most trying sort of war-time conditions and operation; second, by having, even in that period of stress and hurry, kept such a complete, thorough and detailed volume of records of just about everything that transpired, and which might ever be of any use in the future; third, by compiling his records and the results of his experience into the interesting and highly instructive paper, which has been presented to us.

I have found that the reconditioning of flooded electrical equipment, especially main roll drives, is a fairly specialized phase of steel mill electrical engineering which can only be acquired the hard way, that is, by bitter experience, as there is little or nothing "in the book" about it.

We suffered through a lot of this agony at the Steelton plant after the flood of March 1936, so several of us were sent to the Bethlehem plant to help out after their flood. We arrived while the water was still receding, and it would be hard to describe the feeling of utter helplessness which the situation inspired. Here was one of the largest and most important war plants in the world, lying completely paralyzed. There was no electricity available, and so, of course, no lights, no steam, no phone service, no truck service because of the deep mud, and very little labor, as we tried to start to work on Saturday night and Sunday.

Particularly interesting to me, in Mr. Black's paper, were the fine results obtained at the Bethlehem plant, with infra-red lamps, as this was then a rather novel application.

Strange as it may seem, we have every reason to believe that we did get some real benefit out of the flood which struck our Steelton plant just about seven years ago. During these past seven years of operation, we have not had nearly as many failures and troubles with the motors which had been in the flood as one would ordinarily expect, probably thanks to the extremely thorough cleaning, drying, varnishing, testing and other repairing which these motors received right after the flood.

H. E. ODENATH: In the use of the infra-red lamps, did you measure the temperature as compared with the 275 degrees with the other methods?

C. L. EICHENBERG: The temperature of jobs heated with infra-red lamps seldom exceeded 220 F and produced much better results, when compared with oven drying at 275 F. We believe this can be attributed to the greater penetrating power of the infra-red lamps.

R. E. MILLER: Mr. Eichenberg spoke about infra-red drying — I was wondering if they had a pre-arranged program for infra-red drying, and how did they apply it?

C. L. EICHENBERG: There was no pre-arranged program for infra-red drying. The repair shop had one battery of infra-red lamps for normal repair shop demands. This battery was put in service and produced such gratifying results that a rush call was sent out for additional ones.

R. E. MILLER: Then you think that is a better method of drying?

C. L. EICHENBERG: The infra-red lamps produced satisfactory results at much less drying time than any method used at Bethlehem.

A vacuum tank might have produced better results, but since there was none set up, or immediately available, no comparative figures or data can be submitted with this paper.

One thing in favor of the infra-red lamp is portability. It is possible to set up batteries of these lamps at several locations and thus alleviate the congestion which is bound to exist in the repair shop in such an emergency.

M. J. CONWAY: I would like to know to what specifications the safety solvent was purchased which he used for cleaning the motors referred to in his paper. And one other question: Does Mr. Eichenberg consider it possible to use a portable heating unit which will produce a stream of dry hot air at sufficient velocity to reach all parts of the motor, at a controlled temperature of 225 F or so, and if so, would such a device be better than the use of infra-red lamps?

C. L. EICHENBERG: The question on safety solvent can be answered by saying that the exact specifications are not known. It was a standard grade of safety solvent as manufactured, and sold as such, by one of the large oil companies. After experiencing trouble with safety solvent, carbon tetrachloride was used with entirely satisfactory results.

The next question was concerning a stream of dry hot air. Any device that can produce a stream of dry hot air of 225 F and reach all parts of the motor would be very useful. Since the construction of motors does not permit the hot air to come in contact with all parts of the winding, we must necessarily convey heat to these parts by conduction and convection. It was to such parts of the winding that the infra-red lamp proved superior. Heat was placed where most needed.

W. H. BURR: To me, the most essential part of the whole drying out process is cleaning before drying out is started. Unless the equipment, no matter what it may be, is thoroughly cleaned, time will be lost in getting the plant back in service again. During this cleaning process, the benefits derived from painting electrical equipment at frequent intervals become very apparent.

Two main drive d-c motors in our 84 in. mill motor room have been flooded three times. Only a short time before the last flood, we painted these two motors and to our surprise, we were able, on this occasion, to have these ready for service much sooner than on the previous occasions when the insulation was dry and dirty.

Field coils on large d-c machines usually cause considerable trouble. We have found that when trouble is experienced with certain coils and these coils cannot be removed without a lot of trouble better results can be obtained by raising the temperature and then lowering it, this operation to be repeated until drying out is complete. A certain amount of air is driven out of the coil during heating and when cooling other air is drawn in and by continuing this process, in most cases, it is possible to obtain satisfactory results.

Large d-c commutators are always a source of trouble if submerged during a flood. If it is possible to remove the bolts from the commutators, the drying out process can be materially shortened. This will, in many cases,

(*Please turn to page 61*)

Field Balancing OF Rotating EQUIPMENT

. . . . vibration and its dangers are not strangers to steel plant engineers . . . . this discussion reviews some of the causes of vibration and the methods of balancing . . . .

by B. A. Rose

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▲ AFTER rotating equipment has been in service for some time it is generally found to require balancing. Also the cause of the vibration is not always apparent and sometimes balancing is utilized to eliminate the vibration when another type of correction would have given more completely satisfactory results. For this reason this discussion of field balancing includes a description of some of the many causes of vibration which are encountered with equipment of this kind.

CAUSES OF VIBRATION

The discussion will be confined to rotating equipment having no reciprocating masses and if this distinction is made it can be said that the equipment can be balanced so that no pulsating or alternating forces act on the bearings of the equipment. All of the component parts of the rotating elements have centrifugal forces acting on them and if all of the forces are perfectly balanced around the shaft as well as along it, no vibration from this cause will result. Other causes of vibration exist, however, and evidence themselves in the same manner as unbalance and a few of them will be discussed in detail.

Simple unbalance is a common cause of vibration. It results from minor shifts in the weight or the position of the component parts of the equipment. Seasoning of the field coils of a synchronous motor or generator is a typical example. Small movements with respect to the shaft of the armature coil ends of a direct current generator is another. Removal of bolted parts such as blowers and rings, lead cleats, etc., without careful observation of their original position and the returning of them to it when replaced may result also in balance changes.

Balance changes also result from shaft distortion and this cause of vibration is quite common. Internal stresses placed in the forging in the manufacture of it have been known to be relieved through aging and result in a distorted shaft. A quite common cause of distortion of a shaft is the contact of it with stationary parts such as end shields or bearing oil seals during rotation. These rubs, especially in the case of a high speed shaft will produce a permanent distortion by overheating of the shaft locally at the point of contact, and causing yielding in compression of the metal at the point of contact. Figure 1 illustrates this condition. The shaft distortion need not be a permanent condition. Certain types of soft seals which contact the shaft thereby causing generation of heat by friction are apt to cause trouble if fitted tightly against the shaft. Very few shafts are so well balanced that they do not whirl or whip slightly as they rotate and this whipping action produces a heavier contact with the seal on part of the shaft periphery than on the remaining portion. The resulting nonuniform generation of heat around the shaft periphery causes the shaft to distort. Soft seals generally burn away before producing a permanent shaft distortion, hence their effect is present only while the shaft is rotating and consequently are sometimes difficult to distinguish from ordinary unbalance.

Inaccuracy of the face or spigot of a solid flange coupling produces an elastic bend in the combined shaft assembly thereby producing unbalance and vibration. Figure 2 illustrates this condition. The lathes used for machining these shafts, even in the case of the extremely

Presented before A. I. S. E. Philadelphia District Section, April 3, 1943

large ones, can turn the coupling face true within .0005 in. and outages much in excess of this (more than .001 to .002) should be corrected if a lathe is available. Outages of the order of .002 in. of the coupling face will produce sufficient unbalance as to be objectionable.

Shaft distortion must be recognized as the probable cause of most major balance shifts. Small parts of a machine can be moved quite a bit out of position without causing excessive vibration but in contrast to this a change in shaft truth moves the entire revolving mass with respect to the bearing journals and consequently causes major balance changes even though small changes in shaft truth occur. For this reason it is essential in repairing or overhauling equipment to give it the best possible care. Nicks in the faces of solid flanged couplings, shafts bent in the press, galled spots which occur when a shaft is forced into a spider or a coupling, welds of any nature on the shaft surface, spots heated locally by acetylene torches or any number of other things cause shaft distortion and should be avoided. Any solid flange coupling should be checked subsequent to being pressed on a shaft. All coupling faces should be carefully examined for nicks or gouged places. Bearing seals should always be checked for clearance. Careful workmanship pays big dividends in this type of work because the cause of the trouble is hard to find after the machine is installed and is in trouble.

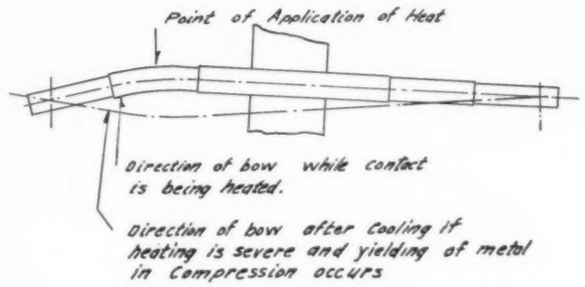

Point of Application of Heat
Direction of bow while contact is being heated.
Direction of bow after cooling if heating is severe and yielding of metal in compression occurs

Figure 1 — Shaft distortion arising from local heating.

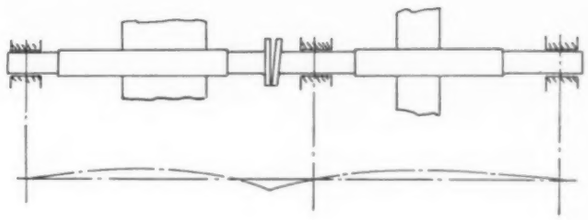


Figure 2 — Faulty coupling faces distort the shafts and unbalance both machines.

Displacing of one or more bearings of a shaft system with respect to a straight line through the set will not cause vibration where solid flanged type couplings are used. In fact the bearings of a series of machines coupled together to compose a generator set or other arrangement are very seldom set on a straight line. The alignment of the set is obtained by bringing the mating faces of each of the flanged couplings parallel with each other and this does not result in the bearings being on a line. The individual shafts deflect due to the weights carried by them with the result that the combined shaft system is bowed upward at the ends and in the case of long sets the end bearings may be as much as ¼ in. above the center ones. This condition does not produce vibration of any kind and the reason that it cannot is that the bowed effect and the forces resulting from it which act on the bearings do not change either in amount or direction with respect to the bearings and, therefore, cannot cause them to vibrate. A displaced bearing in a shaft lineup acts in the same manner.

The magnetic flux in electrical machines can cause vibration which is similar to that caused by unbalance. Nevertheless displacement of a field or armature in the bore of the stationary part will not cause it. This condition produces an unbalanced magnetic pull which can be so great as to pull the rotating member over and contact the stationary member thus causing possible severe damage. The pull, however, is stationary in that it is in the direction of the small air gap which condition is fixed in relation to the bearings, therefore no vibration will result. If, however, we have a rotating field member which is eccentrically mounted on the shaft or is on a shaft which is distorted we obtain an unbalanced magnetic pull, which revolves as the field revolves and produces vibration of the bearings. Machines with small air gaps encounter this trouble in certain cases even though the eccentricity is no more than 10 per cent of the air gap. It is easily distinguishable from mechanical unbalance because it disappears when the magnetic field is removed. Elimination of the eccentricity is the proper cure and where this cannot be done the machine can be sometimes balanced for load conditions and be allowed to run slightly rough when the field excitation is off.

No discussion of vibration of equipment would be complete without a consideration of resonance but in view of the fact that resonance is not a cause of vibration and would require an entire paper itself if handled properly the discussion here will be confined to a brief statement of its effect on vibration. Resonance influences the susceptibility of a system to vibration. Equipment, mounted on foundations or structures which have resonant frequencies equal to the rotating frequency encounter much more vibration, for the same unbalance, than they would otherwise. Therefore, when equipment is found to require balancing often and relatively little balance weight is required to produce large changes in vibration, the question of resonance of the supporting structure should be investigated thoroughly.

WHEN IS VIBRATION EXCESSIVE?

Vibration resulting from unbalance is seldom so severe as to produce fatigue failure in the equipment.

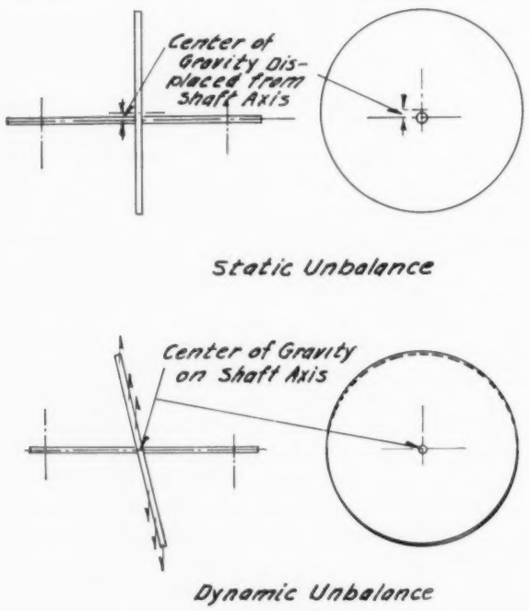
Furthermore, it produces very minor alternating stresses in the shaft. This can best be illustrated by comparing the vibratory motion of the shaft with the static deflection of it caused by its weight and the weight of the equipment mounted on it. Both produce shaft deflections and the deflections in each case can be used as a measure of the stress produced in the shaft. The shafts of large electrical equipment deflect under load approximately .015 to .025 in. and seldom do amplitudes of shaft vibration, caused by unbalance, exceed .003 in. Comparison of these two values shows that stresses ordinarily encountered in shafts, due to vibration, do not exceed one-fifth that caused by the weight of the rotor.

Vibration becomes objectionable because of its effect on collector ring and commutator performance, bearing pad wear and vibration in adjacent equipment and buildings. On the other hand, changes in vibration indicate changes in the equipment and should be investigated to ward off possible subsequential damage. Shaft failures generally warn of their impending occurrence by producing vibration changes.

BALANCING

Two types or kinds of balance are encountered with rotating equipment. As mentioned before two conditions must be met in regard to equilibrium of the centrifugal forces of the component parts of a rotor. They must be in equilibrium around the shaft as well as along it. When the forces are in equilibrium around the shaft, as is evidenced by the fact that the shaft when mounted on a pair of level frictionless balancing ways, will not roll in either direction the "static" balance is satisfactory. Equilibrium of the forces along the shaft gives dynamic balance. These two are illustrated in Figure 3. Static unbalance can best be illustrated by a thin disc which is mounted eccentrically but square on the shaft. Dynamic unbalance alone is obtained if the same disc is concentric with the shaft but out of square such that when the shaft is rotated at high speed the centrifugal forces of the two displaced halves of the disc produce a couple which causes the shaft to vibrate.

Figure 3 — Sketch showing principles of two types of unbalance.



Static balancing on parallel balancing ways will eliminate but one of the above two unbalances. Balancing by means of a "dynamic" balancing machine which rotates the shaft at either medium or higher speed for the balance operation will eliminate both types of unbalance. Static balancing is completely satisfactory on only low speed, large diameter, short machines where the dynamic unbalance is small. Medium and higher speed machines require balancing which eliminates both types of unbalance.

The average repair shop can generally afford to have a dynamic balancing machine on hand for balancing their smaller equipment. It seems unlikely, however, that sufficient equipment of larger size would be handled to justify the purchase of a dynamic balancing machine of suitable size for this work. It would appear that where this work is done in the field these larger machines should be balanced in their own bearings either by the old "trial and error" method or by means of some of the new field balancing equipment available today.

Where single unit or double unit machines are to be balanced in the field the "trial and error" method generally gets good results in a few trials. It involves the placing of a balance weight on one end of the rotor and noting the change in vibration on that end when the machine is brought up to operating speed. The position of the weight around the rotor and its amount is changed until the best overall vibration of the machine is obtained. Measurement of the vibration can be determined by one of the small dial type vibrometers available today. The same procedure is then applied to the opposite end and repeated on both ends until satisfactory results are obtained. This method is admittedly crude but with isolated, single units where time to obtain special balancing equipment and attach it must be considered it will generally be found to be satisfactory.

Complicated sets consisting of several connected units or high speed generators whose rotors are long and comparatively flexible cannot be balanced satisfactorily by the above method and special balancing equipment designed for field use should be used. The equipment recommended for this work is vibration measuring only. It is capable of measuring the amplitude of vibration as well as the phase angle of the vibration with respect to a certain point on the periphery of the rotor. By obtaining readings of the amount and phase angle of the vibration of the shaft at each bearing for the original condition as well as for each trial run the operator obtains sufficient information to enable him to determine the location and amount of the balance weights necessary to eliminate the vibration.

Equipment of the above type is manufactured by several companies today. The photograph, Figure 4, shows a set made by one manufacturer. The equipment must be used by a trained operator if results of value

Figure 4 — The use of special balancing equipment, measuring amplitude of vibration as well as its phase angle, is recommended for balancing complicated sets.

are to be obtained. The equipment is necessarily complicated and costly and the question as to who should own a set should be determined by the volume of balancing work to be done. If sufficient balancing work is done to justify having a trained balancer he should be given the help which the special equipment affords.

DISCUSSION

PRESENTED BY

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F. C. SCHOEN: I would like to add something to what the speaker has said: On small machines, and I am thinking of particularly the motor driving centrifugal gas boosters where you use a large shaft motor going through a lead seal, the machine doesn't vibrate when you are up to speed; you may pass one or two critical vibration points, and as a result, you can't keep packing tight. What is the method of curing this and what is the cause that will set up these critical points while coming up to speed?

B. A. ROSE: I am not familiar with the case you have in mind but from your description I would believe you are thinking of a small high speed two bearing motor which supports and drives a blower which is mounted on a long extension of the motor shaft.

F. C. SCHOEN: That is correct.

B. A. ROSE: A combination of high speed motor and blower of this type will probably pass through the first critical speed of the shaft system in coming up to speed unless special attention is given the design of the shaft and the seal arrangement. If the rotating parts cannot maintain a very good balance the shaft whip at the seal will cause trouble and it would appear that the elimination of the critical speed from the operating range would be the best over-all solution to the problem.

This may be impossible or at best very expensive and a possible alternative would be the use of larger clearances in the seal or the use of a seal which would be flexibly mounted so that it could follow the shaft motion. Use of seal material which could be relied upon to act somewhat as a bearing and restrict the shaft motion through the critical range without encountering excessive wear might also be of value.

F. C. SCHOEN: I cannot allow large clearances at the seal because of leakage. Could an out board bearing be utilized?

B. A. ROSE: The use of an out board bearing would solve the vibration problem but might introduce other troublesome factors which could not be tolerated. It would be worth investigating.

BLACK *Discussion*

(Continued from page 57)

allow the water trapped inside the commutator to drain out through the bolt holes. If heat can be applied to the commutator hub, this will accelerate the drying out of these commutators. Great care must be used not to remove too many of the commutator bolts at one time, otherwise it will be necessary to turn the commutator before it will again operate satisfactorily.

During the last flood we used every method of drying out known including infra red ray tunnels. Very satisfactory results were obtained by this latter method. However, if recirculating car-bottom annealing furnaces are available, more equipment can be dried in less time by this method than any other way. The equipment should be so loaded on the car that temperature readings can be taken on the equipment in the furnace and also proper provision made at time of loading so that insulation readings can be taken without removing the equipment from the furnace. This method provides automatic temperature control and good circulation of air, and insulation readings can be taken with very little delay to the drying out process.

MAINTENANCE *Conservation* METHODS

▲ BECAUSE of the increasing shortages of critical materials and labor, there is great interest in methods for conserving their use, in substitutes for the critical materials, and in extending the life of equipment. Much of the burden of this substitution and conservation has fallen on the maintenance departments. Indicative of the fine work the maintenance men have done along this line are the data presented in a discussion by the A. I. S. E. Chicago District Section, March 2, 1943. The participants were maintenance men from the steel plants of the Chicago area. This report includes the more vital information presented, much of which should be of assistance in our war effort.

SILVER-PLATING COPPER CONTACT SURFACES

Copper is almost worth its weight in gold because it is so badly needed in the war effort, and therefore should be conserved wherever possible. One rather unusual method of conservation calls for silver plating. In an electrolytic tinning line, such as recently installed in a number of plants, there is approximately 4000 feet of bus. There are a great many bolted joints in the runs between the low voltage, high current generators, and the electrolytic tanks. Reducing the voltage drop at these joints permits the use of less copper with a minimum power loss. Silver plating the contact surfaces accomplishes this.

Illustrating the apparatus and method for rapidly coating contact surface of bus bar with silver.

A portable brush plating set was used in one plant for applying pure silver to all the contact surfaces of the copper joints and terminals of new electrolytic tinning lines. An average person can learn to silver plate by this brush method in about a half hour. The silver plating set consists of a small special rectifying power unit which can be plugged into any 110 volt a-c lines, a plating brush which has the appearance of a paint brush, but contains a replaceable silver anode fastened to a metal rod which runs through the handle. Also, there is a silver-saturated electrolyte which is in the form of a thin paste.

Prior to plating, the copper surface must be made chemically clean. The copper surface to be plated is first lightly sanded, then a commercial cleaning compound is used with a cleaning brush or sponge. This completely removes grease and foreign matter. Water is then run over the surface to remove the cleaning compound, and if no water breaks appear, it is considered chemically clean.

The negative d-c low voltage wire from the portable plating unit is attached to the copper bar forming the ground and the positive to the brush. The brush applicator is then saturated with the plating solution and applied at any point where plating is desired. The copper to be plated is brushed slowly with the d-c energized, saturated applicator. This operation while depositing silver breaks up any oxide which would form, destroying the density of the silver coating. The silver anode in the brush or applicator slowly disintegrates or dissolves into the solution during the process of plating, thus replenishing the metallic content of the solution. By increasing the size of the anode, likewise the brush or special applicators, a greater current density is obtained, speeding up the depositing of silver.

One ten-thousandth (.0001) of an inch thickness of pure silver over an average bus contact of approximately 16 square inches can be deposited in 30 to 40

Presented before A. I. S. E. Chicago District Section Meeting, March 2, 1943.

seconds, two ten-thousandths (.0002) in. in one minute, etc.

Silver plating can be used for increasing the capacity of electrical contacts of all kinds. Electrical manufacturers have for a number of years used silver contact tips on relays. They have extended the use of silver plating to heavy duty contacts in order to increase contact capacity, and prevent heating and oxidizing at such points. Electrical manufacturers now furnish fabricated copper bars for cubicles with joints silver plated at all contact surfaces.

Tests have been made which indicate a two-thirds reduction in voltage drop on an air circuit breaker after silver plating was applied to its contacts. After a few months another test indicated a reduction of almost 50 per cent with the same current. The silver oxide that forms at the point of contact improves the conductivity of the connection. It is now mentioned that steel may be used for bus work. If this is required, then it will be necessary to silver plate the contact surfaces. In some locations due to atmospheric conditions, silver plating of the total copper surface of bus bars and switch gears is done to retard and prevent oxidation. Brush plating deposits are less porous than deposits made by other methods due to the cleaning effect of the brush or applicator, preventing oxide from forming during the process of plating, and therefore, requiring the minimum thickness to obtain complete coverage. Plating done by this method does not crack or peel off even under the most severe operating condition.

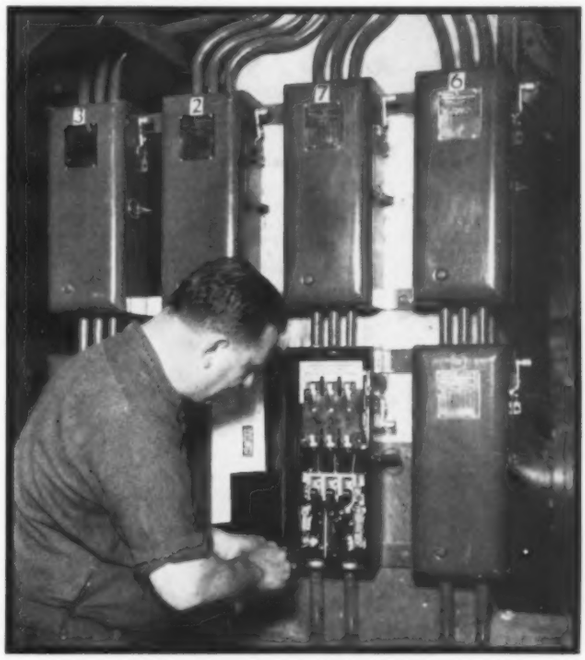
A portable silver plating set is quite convenient for use on small jobs, as well as large jobs. In many cases no dismantling or reassembling of equipment to be plated is required. By the brush method the silver plating can be localized to the parts or spots that require plating.

It is up to everyone to find methods for reducing the quantity of copper, and reduction of power losses in making new installations. Silver plating contributes to our efforts in this respect, and, it is believed, will result in lowering maintenance costs.

SUBSTITUTES IN SHOP PRACTICES

At the start of the war it became apparent that there would be serious shortages of common shop materials as the main sources of these materials fell one by one into enemy hands. It was realized that substitutes must be found immediately. However, the word "substitute" is not a satisfactory one, as in many cases research gives us replacements that are equivalent to or better than the original item if the necessary changes in shop practice are made. However, sacrifices in production that may be traced to shortages of critical material or labor cannot be condoned. At the present time equipment is being used to the utmost which means that maintenance work has greatly increased. Some of the usual materials used for repair are not readily available and in many cases cannot be secured at all. Therefore all maintenance work is examined with a critical eye to determine whether both critical labor and material can be saved. All items, no matter how small, are considered. In addition it is kept in mind that in selecting substitute materials care must be taken not to run from one bottleneck into another.

One of the first objectives was the reduction of the amount of tin used in the mill, as large amounts of tin were being used in both babbitt and solder. Two types of babbitt were being used at one plant: tin base with a tin percentage of about 89 per cent and a lead base with about 1.5 per cent tin content. Formerly tin base



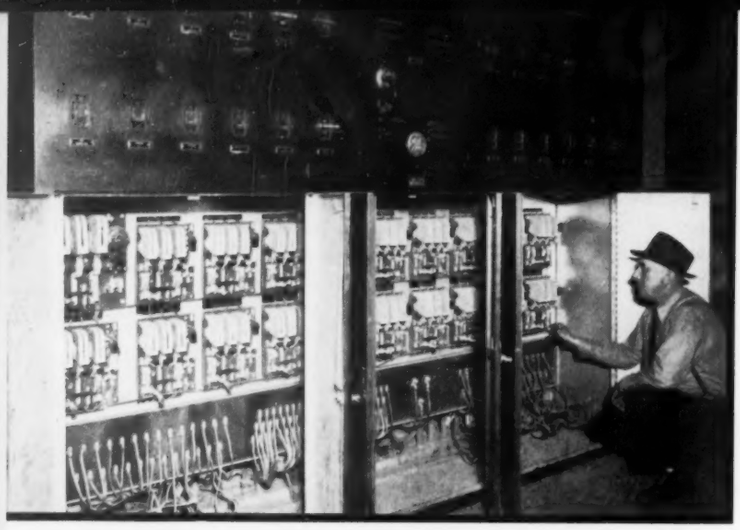
Maintenance should be kept in mind when electric equipment is being installed. Equipment should be accessible for ready maintenance. Controls should be mounted in a clean, dry spot if possible.

babbitt was generally used throughout the mill on any application where the type of load was uncertain. However, as WPB required cutting down on the amount of tin used in babbitt an extensive research program was instituted. At present lead base babbitt is used in all babbitt bearing applications except those in large power and blowing engines and in bearings with thin linings and poor anchorages.

Lead base babbitt has been found suitable for bearing service on roll necks of rolling mill work rolls, fans, electric motors, shears, blowers, roll spindles and pinions, bessemer converter trunions, crushers, exhausters and some table rolls and cranes. This wide variety of application involves a very large number of bearings of many sizes, operating at various speeds, load and temperatures with both hand and automatic lubrication.

The only installations in which lead base babbitt has proven unsatisfactory are those in large reciprocating power and blowing engines where the shock from heavy pounding in the bearings of these engines and slight irregularities in the bearing surface prohibits the use of a lead base babbitt and necessitates a good grade of tin base babbitt.

On all the old bearings sent to the shop the old bab-



Contactors should be inspected regularly, special attention being given to dirt, dust, worn contacts and loose connections.

bitt is melted out of the shell and reclaimed, and new bearings are poured using a 50-50 mixture of reclaimed and new babbitt. All large bearings are allowed to cool for a few hours before being broken from the mold. Formerly both mandrel and bearing shell were heated to about 450-500 F before pouring. Now, however, only the mandrel and shell are heated to about 212 F. It is believed that this will eliminate separation problems sometimes observed in babbitt metal. These separations are believed due to inclusions trapped in the babbitt and forced toward the center by slow cooling of the outer surfaces. The lower mandrel and shell temperatures permit more rapid cooling preventing inclusion concentrations. In addition some experimenting is under way with cooling methods as it seems that there is a wide difference in grain structure in bearing metals broken immediately from the mold, those allowed to cool in the mold, and those slow-cooled in mica.

On bearings with thin shells and poor anchorages, tinning the bearing shells before pouring is being tried, but the results of these experiments are not yet evident. It is easy enough to tin bronze shells but as it costs too much to braze the interior of an iron shell it was not until a tinning compound was found that would tin cast iron bearing shells that tinned shells could be tried.

Some experimentation was done during the first world war in an attempt to reduce the amount of tin in solder. However, no generally tin-free solders were developed but several low tin-content solders were developed to the point where they were used to a certain extent. However, as these solders were of inferior quality, their use was discontinued after the war, and up to the present time there has been little advance in soldering practice.

Present limitations of WPB hold tin in solder to 21 per cent tin by weight for general purpose work As is generally known, there are two temperatures to consider when working solder: the temperature at which the solder starts to melt or the solidification temperature, and the final or liquefaction temperature at which all the solder is liquid. The initial temperature is the same for all types of lead-tin solder between 19.5 and 97.4 per cent tin content. Solders with this range of tin content start melting about 358 F. This melted portion transfers the heat quickly to the unmelted portion causing quick melting of all the solder. As the percentage of tin decreases, especially below the limit set by the WPB, the initial melting temperature increases sharply which means more heat is required and therefore it is harder to work. We have tried so-called substitute lead base solders with various amounts of tin or silver. The liquefaction temperature of these substitutes run 540-580 F, with the solidification temperature well up to 450 F. The heat required to handle this solder is much greater than solder with the tin percentage set by the WPB. These higher heat requirements have been found to destroy or carbonize insulation on leads and commutators. Solders with cadmium have proved satisfactory but as cadmium is as critical as tin there is no point in going from the frying pan into the fire by adopting it. As a result WPB solder is being used while the quest goes on for a satisfactory substitute.

Greatest progress in saving tin used in solder has been by eliminating the soldering process entirely. At present in the shop solder is used only for banding operations and soldering leads to commutators. All end, lead and coil connections are made by brazing or silver soldering. All lugs are pressed on. Experience has indicated that lugs pressed on give a better connection, mechanically and electrically, than a soldered joint, as well as saving labor, solder, flux, tape and heat sources.

Rubber salvage and conservation is quite extensive. Rubber insulation on scrap wire is cut and then stripped from the copper on a rubber stripper designed and built at one plant. This stripper was originally a pipe threader which was converted into a stripper by the addition of cone rollers and a rotating knife. The rubber salvaged is disposed of by the salvage department.

In the shop the leads from the field and armatures were formerly brought out through the frame through short lengths of rubber hose, in order to protect the leads from grounding to the frame. Now, however, bushings made from resinous material are used. They have proved so successful that their use is being extended to drum type controllers and any application where leads are brought through a metal surface where rubber was formerly used. These bushings resist heat and oil much better than the rubber bushings formerly used.

Wherever possible V. C. insulation cable and wire is used instead of rubber. In addition wire is run open for light and power circuits in many locations, permitting the use of either wire salvaged from old installations or weatherproof wire. Knob and tube wiring in offices and shops also save considerable amount of BX, conduit and R. C. wire.

The opportunities to save copper or salvage it are numerous in any shop. In many cases the reason for rewinding brake coils is that the brake coil spool is worn to such an extent by the action of the plunger that it must be replaced. These spools are generally made of cast brass although a few have been made of stainless steel. However, both brass and stainless steel are quite critical materials. Therefore, a spool made of a resinous material is being tried, designed in such a manner that one end of the spool screws off, permitting the coil to slide off the worn spool. This coil can then be remounted on a new spool and put back into service without the necessity of rewinding the coil, cutting down labor and material costs. So far the experimental coils put into service have not returned to the shop, indicating that they are satisfactory. Even if a brake coil wound with ribbon has to be rewound, the ribbon is uncoiled from the coil, straightened where necessary, and rewound.

In the older mills manual type drum controllers and face plate or dinkey controllers are used on many drives. When these controllers come into the shop for overhaul or repair, the segments are carefully scrutinized. The segments for the drum controllers are reversed which just about doubles their life. Worn sections are built up and short sections made from longer damaged ones. Judicious use of carbon blocks eliminate machining operations during building-up operations on segments and contacts. However, consideration must be given at all times as to whether a slug of metal should be used, a piece brazed on rather than indiscriminately building up sections using expensive rod. Labor and material costs must be kept in line as far as possible.

In rebuilding dinkey controllers critical material has been saved and a source of trouble eliminated at the same time. Formerly a terminal block was mounted on the front of the controller through which the motor connections were made to the controller. This block was eliminated and now the leads run directly out of the controller. A lug is pressed on these leads which bolts directly to a lug on the motor leads. The result is a better connection mechanically and electrically and is far safer as no connections are exposed as was formerly the case.

A very important critical item that must be considered at all times is man power. Any change in equipment that lessens maintenance requirements is highly desirable. As an example of this, a certain type of 600 ampere d-c contactor required servicing at least once a week to check on the conditions of the contact arm bushing, shunts, springs and tips. It was felt that this was excessive and as a result the contactor was overhauled with a view toward reducing or eliminating entirely the trouble points. In the original design, the pin passing through the armature arm which supported the contact arms was kept in position by one set screw inserted through the middle of the armature arm. Under steel mill service conditions the set screw would work loose, allowing the pin to rock, which in turn would wear both the bushing in the contactor arms and the hole in the armature arm casting into an egg-shaped form. In order to prevent this, two holes were drilled in the armature casting arm close to the point where the pin entered the hole. Two set screws through these holes now hold the pin rigidly in place, preventing wear in the armature hole and bushing.

It was also found that the contact arm tips ordinarily fall out of line as the tips wear away due to electrical burning and mechanical wear on the tips. In order to prevent this, springs were mounted on the pin holding the contact arm firmly against the armature. These springs are held in place by cup washers and cotter pins. The cup washers next to the contact arm were slit on the rim and bent back forming small ears. The purpose of these ears was to have the inside cup washer turn with the contact arm so that the spring takes the movement rather than have friction between the cup washer and contact arm, thus saving wear on each. In order to cushion this clapping of the contact arm a thin piece of rubber was attached to the spring seat. This tends to prevent rebounding and also save wear on the lower surface of the pin and bushing in the contact arm.

In addition it was found possible to extend the life of the shunt by using a strip of copper as an arc shield. It is believed, also, that all shunts should be made in such a manner that they are reversible. In this way the life of the shunt can be extended by reversing the shunt when it starts showing signs of wear.

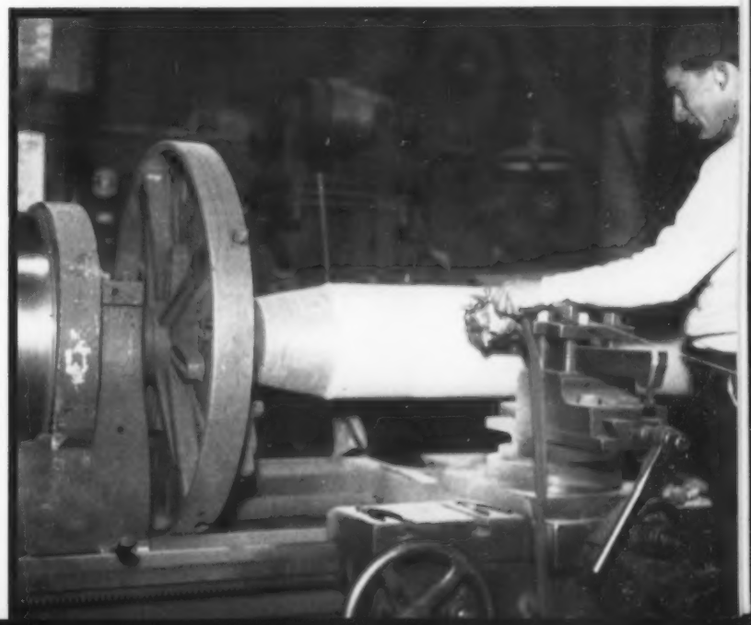
At present this contactor now requires servicing only about once a month and then only requires a general checkup. This is a typical example of the re-designing and modernizing that can be done on old equipment in order to make it function efficiently in this emergency.

METAL SPRAYING

Metal spraying reduces production delays, conserves manpower and saves critical metals. Examples of such experiences reported by one plant are as follows:

Mounted in a lathe, this stop-cock is receiving a sprayed coating of stainless steel.

One-eighth of an inch was added to the diameter of this coiler roll, using sprayed phosphor bronze.



SECURING MAXIMUM SPRAYING SPEED

(From Metco News, Metallizing Engineering Company)

▲ IT is estimated that from 50 to 75 per cent of all the metallizing guns in use today are being operated at uneconomically slow speeds. Modern metallizing equipment is designed to spray at high speed, and to deposit at high speed, coatings that meet all commercial requirements. Unnecessary reduction of spraying speed is definitely disadvantageous and uneconomical for the following reasons:

1. Oxide content in deposited coating.
2. Decreased deposit efficiency.
3. Decreased machineability of coating.
4. Possible increase in spray gun maintenance.
5. Increased cost.

HOW TO SECURE AND MAINTAIN MAXIMUM SPRAYING SPEEDS

In adjusting the gun for maximum speed, the best procedure is as follows:

A. Set regulators at desired pressures and light the gun in the usual manner.

B. Slowly increase the speed of the wire until the gun is spattering rather than atomizing.

C. Slowly raise and lower the oxygen pressure while watching the melting end of the wire. Attempt, by changing pressure, to secure good atomization which will result in the wire melting back closer to the end of the air cap.

D. If after adjusting the oxygen the wire is still spattering, slow the wire feed only to the point where spattering ceases. On the other hand, if the oxygen adjustment results in the wire melting back level with, or close to the end of the air cap, the wire feed should be speeded up to the spattering point and then slightly retarded as before.

The melting end of the wire should always project beyond the end of the brass air cap as far as possible. It should never be level with or inside the end of the air cap.

While spraying, attention should be paid to the flame and the melting end of the wire. If small blue streamers of flame appear acetylene pressure has become too high. Oxygen pressure should then be raised slowly until the blue streamers disappear. If the flame becomes smaller, and the wire appears to speed up and run out of the flame, oxygen pressure is too high and should be lowered slowly until atomizztion is again normal. Do not slow the wire feed.

A production delay of 24 hours on a merchant mill was eliminated by using a spray to rebuild a fan shaft on the job to close enough tolerances to allow the fan to remain in service until the mill was down for repairs. The trouble was caused by the cracking of an inner race which chewed the shaft rather badly. The fan was revolved slowly by hand while metal was sprayed; the shaft was then dressed down by filing, the new bearing installed and the fan put in service. The following weekend the shaft was removed to the shop where the proper repair was made.

Manpower is conserved every time the metal spray is used. A typical example is that of rebuilding the journals of a 3 in. shaft for mill type motors. Formerly it required 12 hours welding and 8 hours straightening after welding. This 20 hours is now entirely eliminated and a complete job of re-building such a shaft by spraying takes only 6 hours, without the pits and holes that sometimes come with welding.

Brass is certainly a critical metal. In some cases a thickness of 3/16 in. has been sprayed on collector rings with good results and it was not necessary to remove the rings from the shaft. Those who have certain types of motor with brass sleeve bearings know that in some cases the outside of the bearing becomes loose in the housing while the inside diameter is still usable; these are kept to standard either by spraying brass on the outside of the bearing or steel on the inside of the housing, thereby increasing their normal life.

A rough estimate of all spray jobs indicates that metal consumption is reduced by 94 per cent and manturns by 75 per cent.

IMPROVED LUBRICATION

The ideal lubricant is oil in its highest degree of refinement for chemical stability, and vast improvements have been made by the use of solvent extracted oils over the acid methods formerly used. These improvements in lubricating oils are clearly illustrated by the modern internal combustion engine in comparison to the oils used in 1920. Since it is not possible to use oil for lubricating all types of machinery, compromises are made according to the design of the equipment. Oil is then compounded with various soaps to obtain desired consistencies and characteristics to resist specified physical conditions. One of the common materials used for steel mill lubrication was black oil consisting of residuums cut back with light ends, and containing 4 to 5 per cent carbon residue. While it is agreed that former black oil applications should be replaced with grease, it is not possible to make the complete conversion in a short time. It has been found that the use of a 1000 S. S. U. mineral oil, although costing 4 cents per gallon more, provides better lubrication with reduced consumption realizing a savings in lubricant costs. The use of a 200 S. S. U. engine oil, 1000 S. S. U. mineral oil, and a 3500 S. S. U. mineral oil, all in the price range of engine oils provides a desirable selection of low priced lubricating oils. This selection is parallel with 6 consistencies of high quality solvent refine mineral oils of the following viscosities: 200, 300, 500, 1000, 1500, 2000, Saybolt Seconds Universal. This selection of 9 oils covers 90 per cent of the lubricating oil requirements for an average steel mill.

Prior to 1915 tar pitch was a common material for lubricating open gearing in many plants, and at that time it was found that petroleum residuums were very satisfactory having the characteristics of adhering to metal surfaces and lubricating gear teeth better. This type of material was used until about 1930 at which time machinery was improved in design by having as much gearing as possible running in oil baths. The de-

velopment of extreme pressure lubricants was made at about the same time allowing high unit pressures.

In about 1940 various lubricants were offered to serve in a better manner the still existing open gearing. Oil was compounded with soap by special manufacture for heat and water resistance, and lead soap was added for film strength. Chemicals were used to increase the adhesiveness of the material to metal resulting in a finished product of any desired consistency. This type of material has proven satisfactory for open gears, bath lubrication and many other applications as a utility grease.

Even though the material proved to be very satisfactory it did not completely replace the gear shield or petroleum residuum. The result was that an improvement was made in the gear shields which required heat for applications. The most adhesive residuums which previously could not be applied without heating, were thinned with non-inflammable solvents that evaporated after application. The advantages of this type of material are as follows:

1. Ease of application.
2. More adhesive resulting film.
3. Reduction in amount applied and in some cases reduction in cost per operating hour.

It is desirable to place gear cases around open gearing insofar as possible, but on old equipment sealing and leakage problems always exist. The use of gear lubricants or solvent petroleum residuums offer solutions to such conditions as well as unenclosed gears.

The centralized lubricating system, whereby the lubricant is pumped through pipe lines and measured amounts fed to the bearings at designated time intervals, is a modern device that needs no introduction. The use of such lubricating equipment is a requirement that industry cannot profitably sacrifice. It is physically impossible to equip all machinery in the desired manner in a short period of war preparation. Therefore, it is expedient that substitute methods are as follows:

1. Long range oilers.
2. Portable volume grease gun in holster.
3. Portable 100 pound air operated grease pump to be used for grease fittings or spraying.
4. Manifolds for grease fittings.

EFFECT OF LUBRICATION ON MAINTENANCE

From "Lubrication", The Texaco Company

Factors Promoting Good Maintenance

(1) CONTROLLED LUBRICATION — Assures positive feed of ample lubricant to protect the bearings or gear teeth.

(2) USE OF QUALITY LUBRICANTS of predetermined characteristics suited to the prevailing operating conditions.

(3) AN EFFICIENT OIL COOLER of ample size to cool the oil in a circulating system to the proper operating temperature.

(4) SETTLING TANKS of ample size to allow water and larger particles of foreign matter to settle out. Settling tanks reduce the load on the oil purifier and oil filters. See that oil return lines to settling tanks are below surface of oil so that excessive aeration of oil and churning can be avoided. Lines from the settling tanks should be so located as to not carry out any separated material with the oil.

(5) EFFICIENT OIL FILTERS OR CENTRIFUGES suitably located in the system in order to remove entrained foreign matter from the oil before recirculation.

(6) BEARING SEALS OF APPROVED DESIGN, and sealing material which will not deteriorate at high temperature due to friction or when in contact with lubricants or water.

(7) SMOOTH BEARING AND GEAR TOOTH SURFACES finished to promote maximum cushioning effect by the lubricating film.

(8) AIR VENTS to relieve back pressure on the lubricant which might cause the seal or housing to leak if the lubricant cannot expand freely with increase in temperature. Where oil is involved, back pressure may be due to small return lines.

(9) PERIODIC CHECK OF THE LUBRICATING SYSTEMS to insure their proper performance, and the assignment, to someone in the maintenance department, the responsibility of seeing that all equipment is adequately lubricated at the right intervals.

Factors Which May Impair Maintenance

(1) OVER-LUBRICATION or use of excessive amount of lubricant, or too high pressure, may result in causing seals to leak, with subsequent loss of lubricant. Usually denoted by sloppy condition around the bearing or gear set.

(2) UNSUITABLE LUBRICANTS which are incapable of withstanding the operating conditions — this may involve poor quality or physical characteristics unsuited to service in presence of prevailing speed, pressure, temperature or moisture.

(3) LOW OIL COOLING OR RECONDITIONING CAPACITY to cause the oil in a circulating system to be overworked or insufficiently cooled before reusage.

(4) SETTLING TANKS TOO SMALL restricting the quantity of the oil in the system, and permitting foaming by too rapid circulation of oil. Oil return lines above the oil level permit aeration.

(5) CARELESS STORAGE OR HANDLING OF LUBRICANTS OR LUBRICATING EQUIPMENT, OR INADEQUATE RECONDITIONING which may result in contamination of the lubricants by dirt or corrosive materials.

(6) IMPROPER SEALING, which may permit entry of water or solid non-lubricating impurities into the lubricating system

(7) IRREGULAR SURFACES OF BEARING OR GEARS OR MISALIGNMENT of either bearings or gear teeth which will cause uneven wear, noise, interfere with lubrication and necessitate time-out for repair or correction.

(8) AIR POCKETS in the lubricating system which interfere with complete circulation of the lubricant, especially at low temperatures, or if the oil or grease is too heavy.

(9) INSUFFICIENT LUBRICATION OR OVERLOADED BEARINGS, which may result in fatigue of bearing metal, spalling, and subsequent scoring by circulation of abrasive metallic particles.

The long range oiler is hand equipment designed for oil containing three gallons, and carried on the shoulder. The oil is moved from the container by a hand air pump forcing the lubricant through a hose and the flow controlled by a regulated valve operated by the opposite hand. The consistency limit of this equipment is the use of a S. A. E. No. 70 oil. The long range oiler was primarily designed for filling sight feed oil cups on overhead line shafting, but can be converted to many other items of useful work.

The portable volume grease gun consists of a 19 ounce lever type hand gun mounted in the holster design for the same type of long range work using a grease in the place of an oil.

The 100 pound air operated grease pump is usable where equipment is accessable, and a greater volume is required. The desirable feature of this apparatus is that it can be used on grease fittings or the nozzle changed for spraying.

The manifolding of grease fittings is a desirable improvement which can later be added to a centralized system.

There are many other novel methods of applying lubricants such as water lubricated bearings, block greases, and permanently lubricated bearings. Although the future will bring other developments, the greatest improvement for the present time is the fullest utilization of available technology and methods.

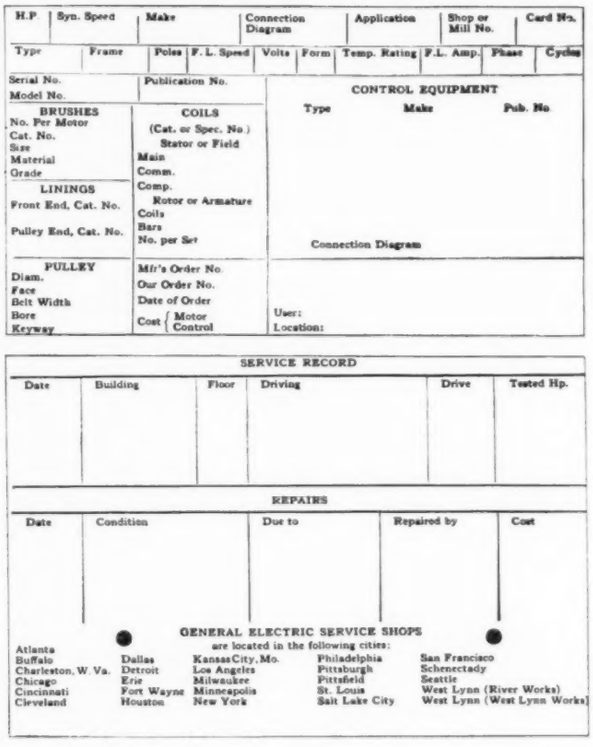
It has been found desirable to have one individual in each department or division assigned the definite responsibility of all lubricants, and their application within the department. This procedure has proved very satisfactory and should be carried to the extent that all persons handling lubricants receive instructions from the division lubricating engineer, thus improving the performance of their duties. In many cases it is desirable to have the persons handling lubricants reporting directly or indirectly to the division lubricating engineer.

SYSTEMATIC INSPECTION AND MAINTENANCE

Through a program of systematic inspection and maintenance of electrical equipment, functioning for about ten years, one large steel plant has shown fine results, reducing armature and stator rewinding to a minor item, and making most of the work regular overhauling, inspection and varnishing.

There are several practices that have been found to work out well in the maintenance of main drive and auxiliary mill electrical equipment in this plant. Possibly the practice of assigning these units directly to the electrical personnel is one of the chief factors in good maintenance. This assignment includes the entire control, motors, brakes, pinions, couplings, and their lubrication; therefore the man is directly responsible for the condition of his equipment. This prevents concentration on the important units causing neglect of the lesser important units, which might result in delays and costs equally as important from an operating standpoint. However, when a man does not have a repair turn to inspect his assigned units, he must line up with his partner or through the work book, to have necessary repairs made to his equipment. Supervision enters the picture through daily inspection of different units with the man to whom they are assigned. This is followed up by a yearly general inspection of all the electrical equipment in the department, by members of the electrical supervisory staff.

Main drive motors and generators, too large to be sent to the electric shop, are disassembled every two or three years, depending on their service and the mill rolling schedules. They are cleaned thoroughly, inspected for loose bands, loose wedges, heating connections, and defective insulation; they are then varnished with air-dry varnish and reassembled. Once a year, and also when the unit is disassembled for varnishing, the bearing, oil rings, shafts, and seals are inspected and necessary repairs made. The bearings are thoroughly cleaned and the oil is changed. Commutators on these machines



H.P.	Syn. Speed	Make	Connection Diagram	Application	Shop or Mill No.	Card No.

Type	Frame	Poles	F. L. Speed	Volts	Form	Temp. Rating	F.L. Amp.	Phase	Cycles

Serial No.
Model No.
Publication No.

CONTROL EQUIPMENT
Type | Make | Pub. No

BRUSHES
No. Per Motor
Cat. No.
Size
Material
Grade

LININGS
Front End, Cat. No.
Pulley End, Cat. No.

COILS
(Cat. or Spec. No.)
Stator or Field
Main
Comm.
Comp.
Rotor or Armature
Coils
Bars
No. per Set

Connection Diagram

PULLEY
Diam.
Face
Belt Width
Bore
Keyway

Mfr's Order No.
Our Order No.
Date of Order
Cost { Motor / Control

User:
Location:

SERVICE RECORD

Date	Building	Floor	Driving	Drive	Tested Hp.

REPAIRS

Date	Condition	Due to	Repaired by	Cost

GENERAL ELECTRIC SERVICE SHOPS
are located in the following cities:

Atlanta	Dallas	Kansas City, Mo.	Philadelphia	San Francisco
Buffalo	Detroit	Los Angeles	Pittsburgh	Schenectady
Charleston, W. Va.	Erie	Milwaukee	Pittsfield	Seattle
Chicago	Fort Wayne	Minneapolis	St. Louis	West Lynn (River Works)
Cincinnati	Houston	New York	Salt Lake City	West Lynn (West Lynn Works)
Cleveland				

The maintenance man should have a card record for every motor in the plant. This typical card includes space for service and repair data.

are watched carefully, and kept well undercut, bevelled, stoned, and polished when necessary, thus giving maximum brush economy.

Accurate service records are kept on the mill type and general purpose motors. These motors are changed after being in operation a year or more, depending on their service, and sent to the electric shop for a general overhaul. Here, defects are caught, such as low resistance fields, loose fields, poor connections, defective bearings, before major breakdowns can develop. This overhaul cost is usually very low when compared to a breakdown in service.

All motor frames and armatures are assigned and stamped with a plant number. All records are kept by

the electric shop of every change that takes place; the electrical foreman in the mill making the change shows, on his order for shop work, the armature and frame numbers of the units installed and removed, days in service, together with other information requested by the shop, thereby giving him and the shop a complete record of the unit. If a unit fails with less than anticipated service, the shop endeavors to ascertain the cause.

Each piece of apparatus, or part thereof going through the shop has a definite routine, test, method or operation which was adopted as standard. Most of these methods and changes were made possible by changing nothing but complete motors before they fail, thereby actually seeing the causes of failures developing in their incipient stages; then finding a remedy to prevent a reoccurrence, as after a motor fails or is badly burnt out this evidence is not available.

The shop is the place where most of these causes and remedies must be found. Therefore, all motor work is done by the shop, where there are the equipment, special tools, and trained personnel to do a thorough job on each motor. Any methods adopted are used as standard practice on all motors whereby the entire plant receives the benefits, rather than confining them to any individual department.

Mill type motors coming to the shop often had the field coils loose on the pole pieces, allowing the insulation to rub through and go to ground. This has been eliminated by installing enough asbestos sheet packing between the coils and frame to completely tighten the coils on the poles. Cases were also found where coils would become overheated, and solder from the wire lead or terminal would run between the turns and short out the entire coil. To overcome this, rigid copper terminals were made up and braized to the field coil ends, thereby eliminating all solder inside the coil. Fireproof wire through a lug is attached to the field terminal with a $\frac{3}{8}$ in. bolt which makes a good, tight joint. The manufacturer usually uses about $\frac{1}{4}$ in. bolt.

On general purpose motors an epidemic of grounded interpoles was experienced. It was found that in most cases these were insulated with fuller board or paper which would absorb moisture; others were held with steel clamps which were continually going to ground. Mica bond is now used for insulation and a new method was devised of retaining the coils to the poles. Commutation difficulties on some general purpose motors, at

Large service machines are sometimes installed in out-of-the-way places, but since operations depend on their proper functioning, a definite schedule of inspection and maintenance should be carried out.

weak field, have been corrected by a stabilizing field on each of these motors.

All motors going through the shop are disassembled, dismantled, cleaned, tested, the fields removed if necessary and replaced with rebuilt field coils, varnished, painted with red, oil-proof enamel, and reassembled with spare armatures taken from the shop rack. They are then given a running test, checked for minimum and maximum speeds, electrical and mechanical neutrals, bucking fields, commutator and oil well covers, proper oil gauges, latch levers, rust proof paint on shafts, etc.

Fittings, such as brakewheels, pinions, etc., wherever possible are installed by the shop. All fittings are heated when applied and this has eliminated the so-called loose fits and bad shafts.

All portable welding machines are completely overhauled periodically. Generators and auxiliary equipment of diesel locomotives are overhauled every three years; traction motors every two years. Special methods must be used in applying the pinions to these motors as there are no keyways in the shafts. Pinions are fitted, heated and applied.

On closed slot induction motors of about 20 hp or less, new methods of stripping, cleaning, and connecting have been adopted. In stripping a gas flame is used to burn out the old windings. Practically all cleaning is done by sand blasting and all connections are made by braizing. Experiments with various kinds of magnet wire in regard to oil, water, heat, acids, etc. have led

RECORD OF MOTOR REPAIRS

(Based on one integrated plant of approximately 2,000,000 tons annual capacity)

Year	Total number of motors and generators in service	Total connected hp	Rewinds, per cent of motors in service	Miscellaneous repairs, per cent of motors in service	Bearing repairs, per cent of motors in service	Shaft repairs, per cent of motors in service	Total shop hours
1938	5,440	434,111	3.9	16.6	7.5	2.7	.....
1939	5,440	434,111	4.9	19	8.7	1.9	31,552
1940	5,532	435,031	5.5	21	11.2	2.3	40,216
1941	5,631	436,041	7.8	17.7	9.1	2.2	42,232
1942	5,848	438,211	6.9	20.6	8.9	.6	43,128

to the use of Formex wire. By using this the wire size can be increased, giving a better motor. Winding time has been cut to less than one-half of what it was originally, through such methods.

Practically all spare armatures are kept in the shop; few are kept in the mills. This expedites work going through the shop and gives time to do a thorough job on any armature coming to the shop. The use of bands on the core has been discontinued wherever possible, substituting a special bronze clip. On numerous occasions loose leads were found in the commutator neck, due to the risers being too high or cut too deep, which necessitated fillers being inserted in the commutator — a common practice in most shops. In such cases the fillers were soldered and not the leads. The top of the commutator risers are turned down, wherever possible, so as to eliminate the fillers and the leads are now being soldered.

All armatures coming in for overhaul receive at least one dip of varnish, more if necessary; rewinds, four dips. All are completely submerged and then baked for 24 hours between each dip. Special presses are used to tighten commutators, thus eliminating stripped nuts and assuring tight commutators. Tapered armature shafts are used wherever possible.

Lifting magnets are handled the same as motors, numbered, and records kept. They also come to the shop to be checked for electrical and mechanical defects.

LOSSES INCURRED FROM WASTE OF POWER SERVICE

Diameter of opening, in.	Compressed air 90 psi		Steam			
			125 psi 50° superheat		275 psi 150° superheat	
	Cu ft wasted per month	Cost of waste per month	Pounds wasted per month	Cost of waste per month	Pounds wasted per month	Cost of waste per month
1	65,100,000	$2,608.00	4,120,000	$948.00	7,720,000	$1,235.00
7/8	49,850,000	1,992.00	3,140,000	720.00	5,900,000	945.00
3/4	36,500,000	1,461.00	2,320,000	532.00	4,360,000	698.00
5/8	25,400,000	1,016.00	1,600,000	368.00	3,000,000	480.00
1/2	16,270,000	651.00	1,030,000	236.50	1,940,000	310.00
3/8	9,120,000	365.50	550,000	126.40	1,070,000	171.00
1/4	4,065,000	162.90	250,000	57.50	470,000	75.20
1/8	1,017,000	40.65	62,000	14.25	115,000	18.40
1/16	254,000	10.16	15,000	3.45	29,000	4.65

Diameter of opening, in.	Water 60 psi			Gas					
				Low pressure			High pressure		
	Gallons wasted per month	Cost per month		Cu ft wasted per month	Cost per month		Cu ft wasted per month	Cost per month	
		Pumped	Purchased		@ 10¢	@ 45¢		@ 10¢	@ 45¢
1	5,840,000	$73.00	$555.00	5,950,000	$595.00	$2,680.00	29,750,000	$2,975.00	$13,380.00
7/8	4,410,000	55.10	420.00	4,550,000	455.00	2,050.00	22,800,000	2,280.00	10,250.00
3/4	3,240,000	40.50	308.00	3,350,000	335.00	1,510.00	16,750,000	1,675.00	7,540.00
5/8	2,250,000	28.10	214.00	2,200,000	220.00	990.00	11,700,000	1,170.00	5,260.00
1/2	1,460,000	18.25	139.00	1,490,000	149.00	670.00	7,450,000	745.00	3,350.00
3/8	810,000	10.15	77.00	832,000	83.20	375.00	4,160,000	416.00	1,870.00
1/4	360,000	4.50	34.20	373,000	37.30	168.00	1,865,000	186.50	838.00
1/8	90,000	1.12	8.55	93,000	9.30	41.80	465,000	46.50	209.00
1/16	22,800	.29	2.16	23,000	2.30	9.90	117,000	11.70	53.00

DATA ASSUMED

Compressed air — 90 psi pressure . . . . . .04 per M cu ft
Steam — 125 psi — 50° superheat . . . . . .23 per M lb
Steam — 275 psi — 150° superheat . . . . . .16 per M lb
Water — 60 psi pressure — pumped . . . . . .0125 per M gal
Water — 60 psi pressure — purchased . . . . . .095 per M gal
Gas — L. P. — 1 psi pressure . . . . . .10 and .45 per M cu ft
Gas — H. P. — 25 psi pressure . . . . . .10 and .45 per M cu ft

They are dried out and refilled, if necessary. In the field, lifting magnets are kept on special drying racks when not in use and occasionally reduced voltage is applied. Most of the trouble has been due to breakage of and loose outer pole shoes. To overcome this, extra heavy outer pole shoes were furnished by the manufacturer in some cases. Outer pole shoes are also welded to the case to relieve the strain on the bolts. This has been very successful. In most cases mica bond is used in rebuilding magnets, ebony asbestos having been found to carbonize readily. Each magnet is vacuum impregnated and filled under pressure.

Magnets and chains are inspected weekly and the magnets tested for grounds. Those operating in steam and water are rotated in service approximately every two weeks. The magnets also are connected to a drying circuit, with the plugs removed, and the moisture driven out. Magnet cable breakage can be lowered by using a cable the diameter of which is large enough to prevent it from double wrapping on the drum.

Magnetic Clutches

(From Cutler-Hammer, Inc.)

Magnetic clutches will give years of trouble-free service if a few simple maintenance rules are followed. An instruction sheet for the particular clutch should be kept on file for complete instructions on the following:

1. Keep the lining adjusted to the correct air gap.
2. Check alignment of clutch to be sure the shafts are not offset.
3. Protect the engaging faces of the clutch from dripping grease or oil.
4. Occasionally force grease into bearing space.

If the above are checked periodically most sources of trouble will be eliminated.

Common troubles encountered in the operation of magnetic clutches are (1) Excessive slipping of clutch, (2) Breakage of spring plate, (3) Excessive wearing of lining, (4) Jerky starting of clutch, (5) Vibration.

A Schedule for
CENTRIFUGAL PUMP MAINTENANCE

(From Allis-Chalmers Manufacturing Company)

▲ "A" timetable, not "the" timetable! Operating conditions vary so widely that to recommend one schedule of preventive maintenance for all pumps would be absurd.

So consider this timetable as relative. But if the recommended inspection and service operations seem entirely too frequent, remember that most pumps are working 4 times as many hours a week as in peacetime. They need more attention now!

EVERY YEAR

1. Remove rotating element. Inspect thoroughly for wear — ordering replacement parts where necessary. Check wearing ring clearances. Generally, they should be approximately no more than .003 in. per inch on diameter of wearing rings.
2. Remove any deposit or scaling. Clean out water seal piping.
3. Measure total dynamic suction and discharge lifts as test of pipe condition. Record figures and compare them with figures of next test.
4. Inspect foot valves and check valves — especially check valves, which must safeguard against water hammer when pump stops.

EVERY 6 MONTHS

1. Replace packing — using grade recommended by pump manufacturer. Be sure lantern rings are centered in stuffing boxes at the entrance of water seal piping.
2. Check shaft sleeves for scoring that would accelerate packing wear — ordering new sleeves if needed.
3. Check alignment of pump and motor — shimming up units as needed. If misalignment recurs frequently, inspect entire piping system. Unbolt piping at suction and discharge nozzles to see if it springs away — indicating strain on casing. Check all piping supports for soundness and effective support of load.

EVERY 3 MONTHS

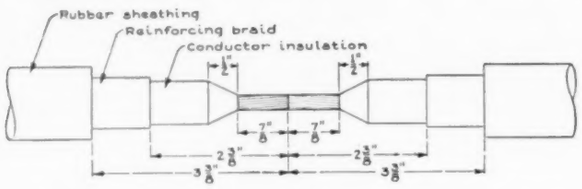
1. Drain lubricant, washing out oil wells and bearings with kerosene. In the case of sleeve bearings, check to see that oil rings are free to turn with the shaft. Repair or replace if defective. Refill with lubricant recommended by your pump manufacturer.
2. Measure bearings for wear, replacing if excessive. Generally, allow 2 thousandths of an inch clearance — plus 1 thousandth of an inch for each inch or fraction of an inch of shaft journal diameter.

EVERY MONTH

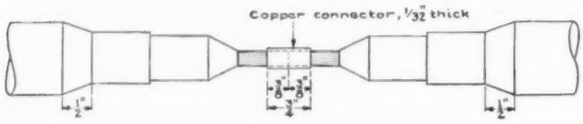
Check bearing temperature with thermometer, not by hand. If anti-friction bearings are running hot, probably they have too much lubricant. Relieve. If sleeve bearings are running too hot, probably they need more lubricant. If change in lubrication doesn't correct condition, disassemble and inspect bearing. Or possibly the alignment of pump and motor should be checked.

HOW TO SPLICE PORTABLE CABLE

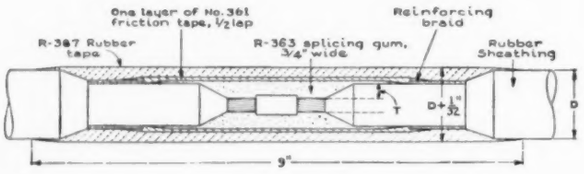
SINGLE-CONDUCTOR JOINT



1. Rubber sheathing, reinforcing braid, and conductor insulation removed, and conductor insulation penciled.

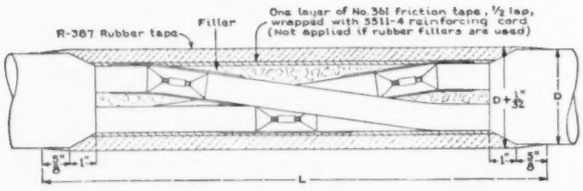


2. Copper connector assembled and rubber sheathing penciled.



3. Splice completed with splicing gum, friction tape, and rubber tape applied. The joint should now be vulcanized.

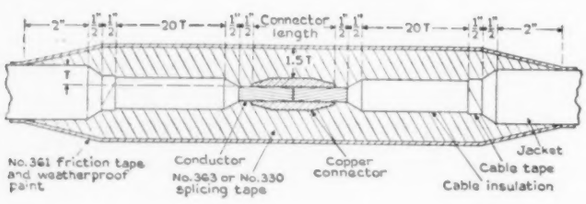
THREE-CONDUCTOR JOINT


R-387 Rubber tape
Filler
One layer of No. 361 friction tape, ½ lap, wrapped with 3511-4 reinforcing cord (Not applied if rubber fillers are used)
D+1/32"
D
L

1. Joint for 600-volt portable type W cable, showing the staggering of individual splices.

HOW TO SPLICE POWER CABLE

RUBBER-JACKETED, SINGLE-CONDUCTOR, NON-SHIELDED

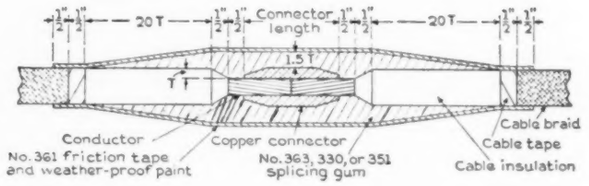


REPAIRING *Cable Failures*

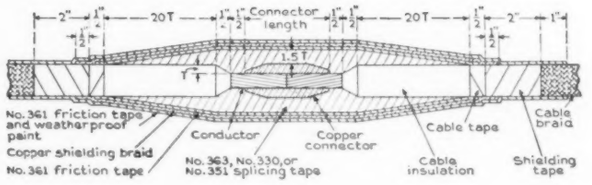
PREPARED BY GENERAL ELECTRIC ENGINEERS

▲ PROPER repair of a cable after failure is very important, and unless it is done properly, another failure will occur in the same spot. Splicing ordinary 600-volt rubber-insulated wire is not a difficult task. However, the splicing of cables for higher voltages and cables of special construction, such as armored cables or portable cables, requires special technique. Since it is important that the splices be made properly, the maintenance man should obtain from the cable manufacturer his instructions for splicing the particular type of cable installed in the plant. If this is done and all instructions

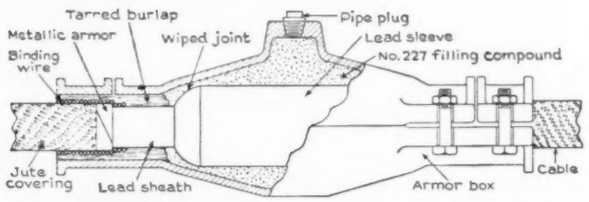
SINGLE-CONDUCTOR, BRAIDED, RUBBER-INSULATED- NONSHIELDED



BRAIDED, SINGLE-CONDUCTOR, SHIELDED, RUBBER-INSULATED



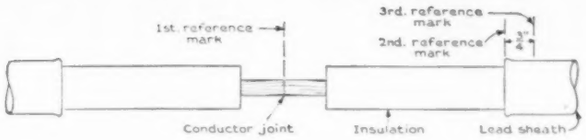
LEADED PARKWAY CABLE



1. A method of installing an armor box over a lead-sleeve joint on leaded JFJ armored prakway cable.

HOW TO SPLICE LEADED CABLE

SINGLE-CONDUCTOR, NONSHIELDED, UP TO 5 KV



1. Cables brought together, lead sheath removed, and enough insulation removed to permit assembling the connector.

are kept on file for quick reference, a splice can be made correctly when the emergency arises.

The use of molding equipment for splicing rubber-jacketed portable cables is recommended for best results. A mold, properly used, will make a splice almost equal to the original cable.

TESTING CABLES

Testing of cables in the field is often done with a megohmmeter, but this method does not always reveal weak spots which result in cable failure. The results may be inconsistent because of the presence of moisture, and the cable may not make intimate contact with the conduit throughout the run.

If a megohmmeter is to be used to test insulation resistance, a guard ring should also be used to prevent incorrect results due to leakage over cable surface.

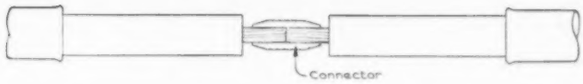
If the cable is operating on an ungrounded system, it is possible that a high-resistance ground fault may develop and not become apparent to the operator. On this type of system, a ground detector should be applied to check for grounds.

Keep a reel of portable or semiportable cable on hand to bridge cable failure while repairs are being made. This will maintain at least a partial flow of power and help cut down a production delay.

An emergency portable cable can be made up from salvaged lengths of cable, and stored in a suitable place. In some instances, it may be necessary to run two cables in parallel in order to carry the same power as the damaged cable.

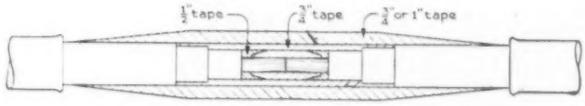
Cable should be stored in reels or in coils in a cool, dry place. Lagging should not be removed from a reel before necessary. If it is necessary to store the cable outdoors, provide protection from the weather. Ends should be kept sealed to keep out moisture. Whenever cable is removed from a reel, the amount removed should be marked on the reel, so as to provide a record of the amount remaining.

All pieces of cable from three to four feet long are worth saving. A cable which can no longer be used for underground service can be used with insulators above ground. Splices in portable cables should be vulcanized, but care should be taken not to overheat the rest of the insulation. Always test splices before winding the cable on reel for storage.

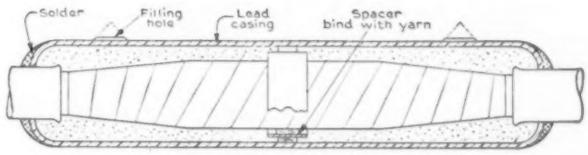


2. Connector assembled centrally over conductor joint.

3. Cable insulation stepped and bound.

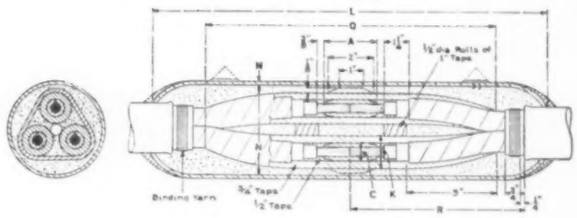


4. Reinforcement tape applied.

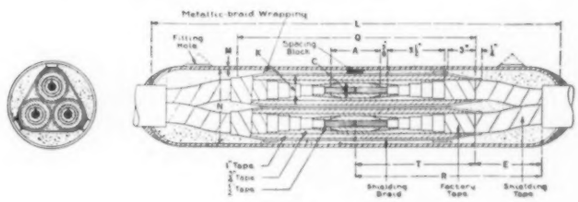


5. Joint completed, with spacer and casing in place, and filled with compound.

THREE-CONDUCTOR, NONSHIELDED, UP TO 5 KV



THREE-CONDUCTOR, SHIELDED, UP TO 15 KV



A. I. S. E. DETROIT DISTRICT SECTION

Maintenance Symposium

J. A. SHIMMAN
SUPERINTENDENT OF MAINTENANCE
ROTARY ELECTRIC STEEL COMPANY
DETROIT, MICHIGAN

W. E. REIBER
ASSISTANT CHIEF ELECTRICIAN
GREAT LAKES STEEL CORPORATION
ECORSE, MICHIGAN

W. L. KIRK
ELECTRICAL ENGINEER
THE DETROIT EDISON COMPANY
DETROIT, MICHIGAN

L. S. VOIGT
MASTER MECHANIC, COKE PLANT
GREAT LAKES STEEL CORPORATION
ECORSE, MICHIGAN

A. W. MOHRMAN
TURN FOREMAN
GREAT LAKES STEEL CORPORATION
ECORSE, MICHIGAN

WARTIME PLANT MAINTENANCE

by J. A. Shimman

▲ MEN and machines seem to be the truly expendable items in 1943. We are setting a pace of production and induction which should lead to either victory or ruin — perhaps both. Some years ago, when mass production of automobiles was in its infancy, the remark was made that this world would someday be nothing but a rusty streak. Those words are perhaps more true today than then.

The 1943 war production, it is estimated, will reach near 80 billions of dollars; will more than double the war output record of 1942 and before June, the United States alone will be producing more steel than the Axis. This means concentration on problems of intensifying production, maintenance, scheduling, work simplification, plant layout, record keeping, training, etc. Management which can make the best use of materials, is resourceful in developing substitutes and careful in making every bit of salvagable scrap count will be far ahead of all others.

Presented before A. I. S. E. Detroit District Section Meeting, March 9, 1943

War shortages will really come home to us in 1943 It appears as though shortages of manpower and materials will really become our major problem in 1943. We'll get enough to eat and wear but not plenty. We'll barely get enough to maintain our plants. Federal controls will tighten up and affect more companies more intensively.

Out of all this increase in production comes more maintenance. When a machine or piece of equipment begins its life it begins to wear out. If we are to stay in business now and after the war our plants must be maintained. There is hardly an advertisement or article in any industrial publication which does not mention or point out the need of more and more maintenance.

There are many reasons why a discussion on this subject appeals to men who are entrusted with the continuous operation and availability of the apparatus that keeps the wheels turning in the iron and steel and other industries.

Webster gave us a definition of maintenance: "See maintain, to hold or to keep in condition; to keep up; not to suffer to decline or fail." He also gave us a definition for repair: "To restore to a sound or good state after damage, waste, injury or partial destruction." It is the first which all maintenance men hope to attain; it is the latter which we hope to avoid.

Maintenance in a modern plant involves several functions.

1. Selection and application of proper equipment.

2. Responsibility for the continuous operation of equipment.
3. Responsibility for adequate design and layout of construction to a varying degree.
4. Periodic and systematic inspection and testing of apparatus and equipment.
5. Control of maintenance costs.

These functions are all important. One, neglected, affects the other. I doubt that any plant manager or maintenance man can truthfully say that all these functions are kept in balance, unless they have hoarded men and materials. With 24 hour-7 day per week operation it is well nigh impossible to keep up more than a scanty semblance of good preventive maintenance.

It has been estimated that the average machine now runs approximately 8000 hours per year as compared with around 2000 hours per year during peacetime. In the day to day necessity to keep things going on a 24 hour basis many things of a permanent nature have to be left undone by maintenance; the demand for immediate operation is controlling. However, there is serious danger that emergency work will become the rule instead of the exception.

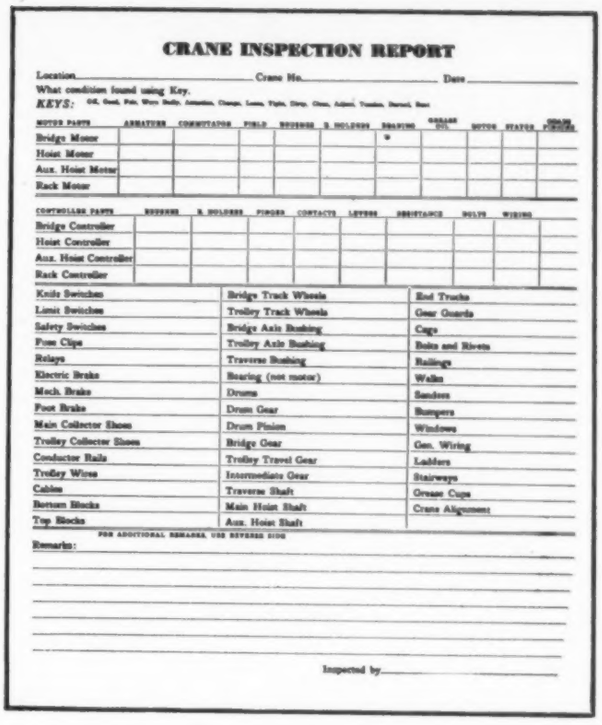
We should guard against the possibility of being caught at the end of this war period with a lot of worn out equipment. Constant reconditioning should be an objective. Industry certainly will not survive (neither will democracy) if we win this war at the expense of our machines. We are not supposed to mention wartime dividends but certainly peacetime dividends cannot be paid out of capital invested in machines. In other words the plant must be maintained.

Plant maintenance covers a huge field of plant operations. We must be prepared to take care of the minutest electrical relay to the largest mercury arc rectifier; from door hinges to gondola stirrups, from the squeak in the telephone operator's chair to the whistles which indicate trouble, from fractional horsepower motors to motors of several thousand hp, to the steam turbines which furnish our electrical energy. We must be prepared to estimate, with reservations, time requirement for construction and maintenance and repair. We must be able to protect our fellow workers, production workers, from the extremities of heat and cold in order that production be carried on or to avert a stoppage of work. We must man the pumps and the boilers. Our work includes the selection of maintenance and construction materials and substitutes. Machines must be kept lubricated with the proper lubricant. We spend thousands of dollars for the best lubricating oils and greases, still our bearing and gear replacement is a very large item. We must maintain our electrical insulation on motors, switchgear, control and transformers. Transformer and switch oil must be checked and properly treated.

Operation and maintenance of overhead traveling cranes is a function of the maintenance department in most plants. It is the crane operator who ties the maintenance department so closely to production.

The average operating man knows little about the stupendous task of plant maintenance. The front-office supervisors, general superintendents, and plant managers must be acquainted with and generally give whole hearted approval of adequate maintenance programs.

With the increasing shortage of skilled help we are



CRANE INSPECTION REPORT

Location _____ Crane No. _____ Date _____

What condition found using Key.

KEYS: Od, Good, Pole, Worn Badly, Loseness, Change, Loose, Tight, Dirty, Clean, Adjust, Trouble, Burned, Bent

MOTOR PARTS	ARMATURE	COMMUTATOR	FIELD	BRUSHES	B. HOLDERS	BEARING	OILERS OIL	BOTCH	HEATER	GREASE PACKING
Bridge Motor										
Hoist Motor										
Aux. Hoist Motor										
Rack Motor										

CONTROLLER PARTS	BRUSHES	B. HOLDERS	FINGER	CONTACTS	LETTERS	RESISTANCE	BOLTS	WIRING	
Bridge Controller									
Hoist Controller									
Aux. Hoist Controller									
Rack Controller									

Knife Switches	Bridge Track Wheels	End Trucks
Limit Switches	Trolley Track Wheels	Gear Guards
Safety Switches	Bridge Axle Bushing	Cage
Fuse Clips	Trolley Axle Bushing	Bolts and Rivets
Relays	Traverse Bushing	Railings
Electric Brake	Bearing (not motor)	Walks
Mech. Brake	Drums	Sanders
Foot Brake	Drum Gear	Bumpers
Main Collector Shoes	Drum Pinion	Windows
Trolley Collector Shoes	Bridge Gear	Gen. Wiring
Conductor Rails	Trolley Travel Gear	Ladders
Trolley Wires	Intermediate Gear	Stairways
Cables	Traverse Shaft	Grease Cups
Bottom Blocks	Main Hoist Shaft	Crane Alignment
Top Blocks	Aux. Hoist Shaft	

FOR ADDITIONAL REMARKS, USE REVERSE SIDE

Remarks:

Inspected by _____

Typical crane inspection report as used in a number of plants.

ever on the alert for short-cut methods of construction and maintenance work. There is danger that this will lead to slip-shod maintenance and consequent increase in production delays. However, on the other hand we will probably find better methods, better materials and thereby gain in the long run. That will be one of the virtues derived from necessity and having to get along with what we have available.

Substitute materials are very closely related to substitute methods and in this field too we will come out of this war victorious also in knowing how to do things better and cheaper. For instance we have to substitute lead-based babbitt for tin-base babbitt. Babbitts which formerly used as high as 90 per cent tin are being replaced with bearing metal with only 1 per cent tin and up to 85 per cent lead content. These bearing metals are, on the whole, as good and for some uses better.

Silver is replacing copper in electrical equipment to some extent. Contact parts of switches are being built up by welding with silphos and phos-copper. They are then smoothed and silver plated.

Babbitt bearings are being built up by metal spraying instead of by melting and repouring. Time is saved. Intricate equipment parts are made by hand from scrap pile parts when they can not be bought or delivery is unsatisfactory. Worn or used parts removed from service years ago are being repaired and reused for emergency service. Welding is being used increasingly to repair broken parts. Metal spraying is proving effective when properly applied in building up worn parts.

PLANT ELECTRICAL MAINTENANCE

by W. E. Reiber

▲ THE electrical department of the Great Lakes Steel Corporation is responsible for the maintenance of all electrical equipment. This includes 51 direct current generators, 5,233 motors, 101 overhead cranes, 3 electric locomotives, 9 oil-electric locomotives, 12 yard cranes, 22 electric tractors, 25 gas electic units, electrical control, transformers and plant lighting.

In order to maintain this equipment, the electrical department is divided into sections, such as No. 1 open hearth, No. 2 open hearth, merchant mills, blooming, bar and strip mills, No. 2 strip and cold mills, electrical construction, motor rooms, meter repair, locomotive repair and crane repair. Each group is supervised by a general foreman, who is responsible for the maintenance, and for crane and motor room operators.

Delays of any kind curtail production and generally cause higher costs of the product. We try to instill into the minds of maintenance men that there is a certain pride in keeping down delays and keeping up equipment. If you have ever worked with a good conscientious maintenance man you will find that this is true. You will even find out that there is rivalry between turns to see who has the least delays. We give each general foreman a monthly report of the delays charged against him. In turn he posts these delays. In this way we keep delays in the minds of the maintenance men.

During the year 1942 we had a greater number of delays and more time lost due to these delays than we had in 1941. In trying to ascertain a reason for these two contributing factors were noted: First, and largest, of these is the tremendous increase in the turn-over of maintenance men due to their being inducted into the armed forces and changing from one job to another. The next factor was the changing of our product from automotive to specialized steel, which was harder on our equipment.

You can not place inexperienced men on the job and expect very good results. You can not make a maintenance man over-night because this work is entirely different. A maintenance man such as a motor inspector who has had years of experience generally gets the ailing piece of equipment repaired right while it is working, thereby saving costly breakdowns and delays. He has many short cuts to obtain results. You have to get very well acquainted with him before he will part with his knowledge that he has spent years to acquire. At times during his inspection trip he may find something that can not be taken care of while equipment is operating; then he should make a note of same so it can be repaired at the earliest convenient time or over the week end shutdown period.

I do not know of any school you can go to or any book you can buy to learn the art of maintaining equipment. It is true you can obtain some knowledge of this phase out of schools and books but you do not get the fundamentals or the secrets of maintenance. To help the condition the electrical department at Great Lakes has a practical electrical school for their men. This school is entirely a practical course with just a little theory in order to understand electricity, such as Ohm's law and magnetism.

The classroom is 34 feet by 37 feet, and well lighted. We have gathered together spare equipment such as motors, motor generators, control boards, contactors, brakes, controllers, solenoids and a lot of other equipment that he comes in contact with every day. This class is held two nights each week and the course lasts for 12 weeks. In this course he covers magnetism, series and parallel circuits, Ohm's law, motor and control repair, and motor and control trouble shooting. We have a motion picture machine and a slide projector with a series of 880 slides showing different theories, electrical machinery and control. To make it easy for those learning electrical motor and control circuits, we have large size sketches showing the most important circuits.

Hook-on volt-ammeter as shown here are of considerable help in detecting overloads and heading off trouble.

The instructor of this class was one of our own men well qualified for the job, who had been a good motor inspector in the past and is now a general foreman. We believe that to teach practical elementary training you must have a person who has had this kind of training. If you do not use this method of training, invariably too much theory is taught, and theory to the average motor inspector is just so much water over the dam. He loses interest in the course and finally gives it up for a bad job.

Good maintenance has a certain number of records that must be kept. If certain data is not kept, the recurrence of breakdowns is never caught, and if you do not try to get away from recurring breakdowns, you have no maintenance.

Getting back to the more technical side of this discussion, our 51 direct current generators have a capacity of 79,000 kilowatts. The total rated horsepower of our 5,233 motors amounts to 317,780 horsepower. A large percentage of these motors operate under magnetic control, making a large control problem.

We have had to substitute and make some of our own parts to keep equipment operating. After all it is nothing new to cut a coil, contactor or a resistance unit out of the circuit and still have equipment operating. There are numerous items of interest, however, in regards to recurring breakdowns. Some are worthwhile mentioning:

We had a control problem involving very frequent and severe plugging of contactors, causing contactors to freeze in. Invariably this particular operation caused trouble and delay every day. In order to eliminate this trouble we installed contactor tips of carbon and graphite base.

Certain master controllers which used copper brushes in the sweep arm against copper segments caused considerable renewal parts to be used due to excessive wear. As you know copper to copper in a sliding motion does not wear well. Here we installed carbon brushes to cut down costs, delays and waste of vital materials.

We had considerable trouble with the breakage of rotor shafts on a table installation. These rotor shafts have a steel pinion and drive two rolls through steel gears. Severe plugging caused rotor shafts to snap. When the rotor shaft broke it would generally damage both pinion and gears. We installed V-belts in place of the steel pinion and gear drive, thus ending the breakage of rotor shafts.

In some cases when a motor is overheated, causing windings to burn up, due to overload or excessive reversals, forced air is added by installing a small blower.

Our cranes are mostly of mill type. The total rated tonnage for the 101 cranes amounts to 4,254 tons. It requires 11½ miles of steel cable to equip these cranes; 592 bridge trackwheels are required to keep these cranes operating. You can readily see where a great percentage of our crane problems lie. We have been quite fortunate with our crane maintenance as our spares were in good shape. We have forged out trackwheels, and have substituted brass for roller bearings at various times.

Numerous ingenious make-shifts are practiced in present day maintenance. For example, we installed a crane and were having trouble with breakage of the bridge armature shaft. After due observance of the drive we decided it needed an additional bearing to take the whip out of a shaft extension which was coupled to the armature shaft. We could not find any bearing in stock to do this job. So we made the pedestal bracket and installed a wooden bearing. This installation is still in service after months of service.

Again, we were lacking sufficient crane service to handle steel products which required inspection on both sides. By installing a steel boom and a magnet, and using electric trucks, we were able to handle the steel easily. We now have seven of these units.

Good maintenance can be obtained by keeping good records, adequate spares, proper tools, proper lubrication, rigid inspection, safety, common sense ideas and, last but not least, cleanliness.

TRANSFORMER MAINTENANCE

by W. L. Kirk

▲ IN the maintenance of transformers, as with any other maintenance, we are interested in lower costs. We endeavor to anticipate the trouble and have all defects corrected before the trouble actually happens. This is accomplished in different ways:

A. By inspection.
B. By routine maintenance.
C. By proper reconditioning of equipment.

INSPECTION

Transformer inspection may be divided into four different classes:

A. Factory inspection of new transformers.
B. Reconditioning old transformers.
C. Installation of transformers.
D. Routine maintenance of transformers in the field.

All new power transformers are inspected in the factory, while they are being made to see that they conform to our specifications. All transformers, both new and reconditioned, receive a thorough inspection and complete tests in our testing laboratories, before they are installed. Any defects in material or design are invariably caught before they become a hazard to our system. Our actual maintenance costs are relatively low because we insist that all parts are exceptionally good, both electrically and mechanically.

The standards which we have developed are the responsibility of one man who makes the final decision of all suggested improvements. We have one person, and only one, who steers the ship of inspection and maintenance, thus eliminating confusion and discord. However, we have many individuals who work up and pass on many valuable suggestions, which are discussed and finally acted upon by the one person who is the last word on standards for our department.

During factory inspection of new transformers and reconditioning of old transformers, we pay particular attention to the following items which are great factors in lower maintenance costs.

A. *Waterproof tank* — The tank shall be constructed so water cannot enter. No holes, such as for studs, shall pass through the cover. The top shall have no low spots to hold water.
B. *Welds* — All welds shall be tight and non-porous, and shall not leak under oil or gas pressure.
C. *Gasketed joints* shall be metal to metal type with stops and retainers arranged so the gasket is evenly compressed the correct amount to form a perfect seal. Splices shall be properly scarfed and cemented. Gasket retainers are essential to prevent the gasket from being drawn in under vacuum.

On machined surfaces we use duprene or synthetic rubber.

On fairly smooth surfaces we use corprene, which is a mixture of cork and duprene, compressed about 33 per cent.

On rough surfaces we use a good grade of cork compressed 50 per cent.

The surfaces shall be free from scale, deep indentations or radial scratches which may cause leaks.

D. *Transformer top* shall be sufficiently thick and the holes close together so the gasket will compress evenly, and not only at the bolt holes. A thin top, with the holes spaced widely, will cause a wavy condition and an uneven compression which would allow water to enter.

E. *Bolts* — All cover bolts and bolts for electrical connections are high strength, to prevent stretching. The nuts inside the tank are locked so they cannot fall into the windings. No split spring lock washers are used. Where practicable, locking straps are provided for all nuts.

F. *Rust prevention* — The outside of the tank bottom is zinc sprayed. The inner surface, above the oil, is parkerized and painted with oil resisting paint. All parts are made accessible for painting.

G. *Connections* —

All moving and stationary contacts are silver plated.

All bolted connections are silver plated or tinned.

All permanent splices and connections are brazed with silver. Soldering is not secure and phos-copper is brittle.

H. In addition to all these, factory inspection requests:

1. First class workmanship.
2. Creepage and striking clearances to be within tolerances.
3. Coils to be tightly wound and properly anchored.
4. Improved transpositions and extra insulation at these points.
5. Proper bracing throughout.

ROUTINE MAINTENANCE

Proper gasketing and strong tanks are necessary to prevent oil and gas leaks and to keep water out of the oil. Water deteriorates the oil and insulation, the vital parts of a transformer. We make a dielectric test of the oil every six months to determine whether any water has entered. With proper care and protection of the oil, we have very little handling of oil from transformers.

Our planning division keeps a close check to prevent overloading of the transformers which protects the insulation and also prevents sludging of the oil. We use two methods of preventing oxidization of the oil. One is the use of a conservator tank and the other is nitrogen

←

Temperature readings for oil transformers should be taken with alcohol thermometers as mercury is an excellent conductor and might cause damage. Temperature should not exceed 80 C. Wrenches, screwdrivers and thermometers should be tied securely to the inspector's belt as tools dropped into the windings and not retrieved might cause a breakdown.

▲

Dielectric strength of transformer oil may be tested by a portable testing set as shown here.

↓

All heat-radiating surfaces should be clean and free from oil and rust. Paint tanks and covers as often as required by local conditions.

gas under pressure over the oil. The oxygen content of this inert gas is left at less than one per cent. When it exceeds 2½ per cent, as shown with a gas analyzer, the transformer is purged with nitrogen gas.

We make periodic inspections of transformers every three years, which in part covers meggering the windings and wood parts. If poor results are found, then a thorough check is made of the oil as to power factor and acidity.

If the wood parts megger poorly, they are boiled in mixed oil at less than 300 F. The time for drying varies from 8 to 24 hours, until water bubbles have stopped rising to the surface of the oil. After they have cooled to 150 F and test 10,000 megohms, they are given two coats of spar varnish.

Water coils are blown out each fall to prevent freezing, and are given a 250 psi hydrostatic test.

In the installation of transformers, the units are examined for any damage caused by transportation. All clearances are checked and the transformer properly grounded. Connections are slack enough to prevent strain on the bushings. Connections are tight enough to prevent whipping by wind or surges.

In addition to the foregoing, additional items which might be mentioned are as follows:

In order to check connections and contacts, we use a special contactivity tester, designed and made by our company. In this way we find poor and loose joints which may appear good.

To prevent condensation and rust, we use heaters and proper circulation of air. We also use non-corrosive materials extensively and eliminate a combination of metals which accelerate corrosion.

We keep the outside of the transformers free from oil to prevent fire hazards, and also for appearance.

SOME PHASES OF PLANT MAINTENANCE

by L. S. Voigt

▲ ANY plant production record can be beaten over and over in peacetime. It can be done more often, but at greater cost, in times of war. Your newspaper prints daily records of such accomplishments. A prerequisite for this improvement is, among other things, a good top management and a properly balanced maintenance division. My remarks will be centered on maintenance. At the present time, good old machines are a lot better than new ones on order which cannot be delivered. Your own plant yard may contain some of the acre of diamonds for which you have been searching elsewhere.

We should strive continually for improvement. First, progress demands it of us; we must move forward or else be replaced by others. Next, the national emergency requests it. And finally, improvement must be made if we expect to retain our free ways of life and win this struggle quickly.

Now that we have the problem, what do we expect to do about it? The methods proposed here are not new. The maintenance work should be planned intensively. Make provision to beat the normal replacement jobs before the plant delays beat you. Plan ahead as far as possible for the emergency jobs which you can visualize for the future. Make the work easily done by furnishing the proper tools, equipment, and materials needed. The stock materials should be easily accessible and the spare parts for machines should be stored and grouped so that they may be found easily when needed. Identification tags should be placed on these parts. As to making the jobs easier, I will call attention to the fact that our blast furnaces are among the first to install top rigs for changing bleeder valves. We have installed numerous jib cranes to make certain repair jobs more handy. For feeding anti-freeze mixture into our gas holder when the piston seal is leaking due to ice conditions, we have installed 68 one quart drip cups. Line sketches of the main steam lines and the underground water lines, with location of the shutoff valves, have been framed and furnished to the mechanical and operating departments for emergency use.

In our plant we have three large blowers for mill gas delivery. These are equipped with river water sprays in the inlet. This water, of about six grains hardness, deposited a heavy scale over the vane controls, wheels, casing and caused the discharge valve to leak so badly that it was difficult to dismantle a machine for cleaning. A zeolite water softener was rigged up from an old tank on hand, and later sand filters for the water were made from pieces of old gas main. The results were such that the blowers are now cleaned at periods of six months instead of six weeks as previously. The soft water also dissolved the scale from the shut-off valves so that they are again usable. Gas capacity increased to normal and a labor saving of approximately $2000 annually was made, over and above the power saving.

GREAT LAKES STEEL CORPORATION
Coke Plant

/[illegible] CONVEYOR

Drawing L 13937		Bearings
Speed Reducer	Size 9-LH	HS 2-310
Order	------	Pinion-shaft
RPM	1160	Int 2-315
Ratio	62,63-1	Gears-shaft
W.O.		L.S. 2-74472-850
Input H.P.		Gear- shaft
Base	WBl--Welded	
Brake	#2--80966	
Motor	Induction	
Type	Dust proof	
Size		
Power	60 Cy- 3 Ph- 440 Volt- 30.8 Amp	
RPM	1170	
HP	25	
H.S. Coupling Flexible #2-1/2 --- #84902		
Motor Shaft-Dia.	2-1/8	
K.S.	1/2	
Reducer Shaft-Dia.	1,397	
K.S.	1/2	
L.S. Coupling Flexible #5 ----84803		
Reducer Shaft-Dia.	4.687	
K.S.	1-1/4	
Driven Shaft-Dia.	4-7/16	
K.S.	1-1/8	

GREAT LAKES STEEL CORPORATION
Coke Plant

/[illegible] PUMP --OVEN FLUSHING LIQUOR

Drawing		Bearings
Motor	Explosion proof	
Type	Induction	
Size		
Power	60 Cy- 3 Ph- 440 Volt-- 151 Amp	
RPM	1790	
HP	125	
Turbine		
Type		
Steam		
Exhaust		
RPM		
HP		
Pump {Cent Flex-- # 10		Line 2309 Thrust 7409
Type	LAl	
Size	GPM--3500	
RPM	1790	
TDH	110	
HP	125	
Packing	2-1/2 Shaft-- 5 rings 1/2"	
Coupling	Flexible # 2-1/2 ---# 90413	
Drive Shaft-Dia.	2- 3/8"	
KS	5/8	
Driven Shaft-Dia.	1--3/4"	
KS	3/8	

BELT RECORD

CONVEYOR No. #6 Coke SHEET No. #6 C

For description of layout, pulleys, etc., see other side this sheet or Sheet No.

Description of Belt No. 6 Third change

Make
Brand Duck Wt. 28 oz
Seller
Order No.
Length 132 ft Width 36"
Plies 6 If step-ply, plies at edge at middle
Top cover 3/4" Back cover 1/32"
Ends joined by vulcanized joint?
Lacings used, Type Bolt Size 1-1/2
Best previous record—Belt No. 6 Tons 5348 Cost per ton $

Date received
Date installed Oct 28, 1941
Date removed Oct 12, 1942
Time in use 11-1/2 Months
Price per foot $ 6.15
Invoiced cost $
Cost of repairs $
Total cost $
Total tons 856,238-- 6486 Tons/ ft
Cost per ton $

Tonnage Record

YEAR	1941	1942				
Jan.						
Feb.						
Mar.						
Apr.						
May						
June						
July						
Aug.						
Sept.						
Oct.	28	22				
Nov.						
Dec.						

Maintenance of Belt
Lacings renewed—repairs—etc.

Nature	Date	No. Hours	Rate Per Hr.	Labor	Material
Install new lacing					
Lubrication					

Remarks --- Accidents --- Final condition of belt --- Recommendations

Belt worn out in center section
Recommend new inlet chute design

For record of next belt on this conveyor see Sheet No.

Form 992

Sheet No. 6 C Description of Conveyor No. 6 Coke

For description of belt see other side.

Location Track load boom Plant Hanna Fce Covered? No Exposed? Yes
Machinery installed, date 1938 by -- made by ----
Center to center 63 ft Difference in elevation 17 ft Incline, degrees 21 Max
Driven by Motor H. P. running 3 Belt Speed F.P.M. 223 Belt Tension ---
Tandem drive? --- Snub drive? --- Simple drive? Yes Pulleys lagged? Head
Screw take-up? Yes Counter weighted take-up? --- Weight on take-up ---
Limit of take-up in number of feet of belting 2 ft
Idlers, type: top 17 bottom 5 Spacing, top 4 ft bottom 10-
Idler bearings: plain --- roller Yes ball --- Guide Idlers? None
Type lubrication Pressure How often lubricated? Monthly
No. of trippers: travelling --- fixed --- Brush or cleaner ---
Material Furnace coke Maximum size 4" Per cent Fines ---
Wet or dry? Dry Temperature Warm Lbs. per cu. ft. 28
Method of Loading, Chute Yes grid --- Drop in feet 1
Number of loading points 1 Average tons per hour 156 week ---

Sketch

Drawing L-13627

15 Troughers 253 XR5---W 10725-36
2 Idlers 59163x
4 Idlers W 9396-36
1 Tail pulley 20x38x 3-x 2-15/16--- 59205x
1 Head pulley 20x38x 3 x 2-15/16--- 59220x
1 Bend pulley 12x38x 2-1/2 x 2-7/16---59214x

(Dates of any changes in foregoing conditions)

Changes

Original speed---- 123 FPM
Feb 14,1939 155 "
Oct 31,1939 223 "

In plant maintenance it is necessary to coordinate the work so that certain men have the responsibility of the daily routine of lubrication, inspection and light repairs. The floating gang is used for the heavy repairs and those jobs requiring particular skills. Routine clean-up of all out of place materials, metals and rubber is particularly essential at this time. Such of these materials as can be used again should be placed in good condition in the handiest location possible. Repairmen will take the line of least resistance and use this old material instead of the new. At the present time, our plant is building a gas washer from an old stove shell. Last year we made a garage for bulldozers from old material. On this job we defined a roof purlin geometrically as a channel made up of its component parts welded together. Just now we are overhauling six heat exchangers. The tubes (16 ft long) removed are being cut into usable lengths of 13 and 7 feet lengths for other installations. The waste from this job will be small.

A reasonable amount of mechanical records are necessary and very helpful. It is well to keep copies of all material and parts orders with the price checked off as received. This will facilitate the ordering of new materials and avoid duplications. Excess supplies at this time should be guarded against. Data lists of spare parts as applied to the various machines are very handy, particularly if the record is made in tabulated form. Normal usage of material should be recorded so that some idea can be gained of the frequency of changes made. From this we learn to alter design or change the type of material used. Emergency breakage deserves a study also and the responsibility should be placed if possible. I would recommend that a written report be made by the mechanical and operating departments, these reports later to be discussed by the heads of both departments and a decision made as to prevention and recurrence. Disciplinary action need not always be applied.

As to the keeping of records previously mentioned, several examples are presented here. The first shows the machinery drive data for a conveyor. The second is a sheet showing size and capacity values for a pump. The third sheet shows the performance of a belt. The next gives us the specification and parts for the same conveyor. Our conveyor records cover the performance of some 16,000 feet of belts. I would propose that a monthly cost sheet be made for the mechanical division.

In this discussion, I have made a few remarks on intensive planning of the jobs, coordination of the work into its various phases, the use of salvage equipment and material, and I have talked of the importance of keeping necessary records. This is indeed an opportune time for maintenance department to do its utmost to make the old machines good for the duration and break more plant production records.

←

These examples of recorded information kept in a coke plant show the drive data for a conveyor, the characteristics of an oven flushing liquor pump and its drive, and the performance and description of a coke conveyor and belt.

MAINTENANCE DETAILS

by A. W. Mohrman

▲ IN some plants, maintenance is a mythical operation; the equipment is given only a hasty inspection (or none at all) due to lack of help. Lubrication is either overdone or rarely done at all. Equipment can pay dividends and produce only as long as it is kept in operation. Consequently the investment of regular, thorough inspection and lubrication is one of the best — especially at this time.

Wartime maintenance calls for highly practical maintenance information consisting of records which show horizontal, vertical and cross-sectional measurements, speeds, horsepower and characteristics pertaining to interchangeability, in order to save time in case of breakdowns.

The maintenance foreman should have data sheets such as supplied by the manufacturer, blueprints pertaining to equipment in his charge, helpful information pertinent to motors, generators, brushes, conduit, method of control, pinions, pulleys, couplings, etc. It is well for him to have in his possession a book containing nameplate data of all equipment, properly indexed, and cross-filed to show where it now serves and the number of units which have the same item attached; also, whether or not a spare is provided, or whether some other unit is interchangeable.

This card record for a d-c arc welder gives characteristics of the unit as well as a log of its service and maintenance.

Amp.	Speed	Make	Connection Diagram	Application	Shop or Mill No.	Card No.
Type	Motor Voltage		Time or Duty Cycle	F.L. Amp.	Phase	Cycles

Serial No. Model No.	Publication No.	Mfr's Order No. Our Order No. Date of Order Cost.
BRUSHES No. Cat. No. Size Material Grade	COILS (Cat. or Spec. No.) Motor: Stator — Main, Comm., Comp. Generator: Field — Main, Comm., Comp.	
BEARINGS Front End, Cat. No. Motor End, Cat. No.	Motor: Rotor — Coils, Bars, No. per set Generator: Armature — Coils, Bars, No. per set	User: Location:

SERVICE RECORD

Date	Shop	Floor	Service (Tacking, etc)	Duty Factor	Tested Load	
					Volts	Amps

REPAIRS

Date	Condition	Due to	Repaired by	Cost

MAINTENANCE

Greased		Inspected		Cleaned	
Date	By	Date	By	Date	By

In many plants the equipment is divided among a number of workmen who are held responsible for their upkeep; they also keep a book record of equipment and their regular inspection and findings. Inspections as a rule are delegated to a careful mechanic who makes regular daily, weekly or monthly inspections as may be required. This does not mean unnecessary tinkering; adjustment should be made only when necessary, yet detection of possible excessive wear, loss of power, overloads, accumulation of foreign material should be noted and records made together with the date in the form of a regular log. This log should cover all inspection findings, adjustments and repairs. In this way, parts calling for excessive care or repairs can be spotted, the cause investigated, and corrections made to avoid serious damage. Also, these findings may change the date of inspection to longer or shorter intervals.

In addition to the above inspection, at assigned intervals a committee made up of foremen makes an inspection, observing conditions in the various departments.

If, for any accidental reason, production stops, the maintenance man is put to the test. He must find the trouble and restore operations with the shortest amount of delay. He must be found at once, usually by means of a personal call system. He must have at his disposal men and equipment to facilitate quick repairs. A mobile repair shop, equipped with cutting and welding torch, power lubricator, hand tools, slings, ropes and perhaps small parts is of considerable help.

Whether it be maintenance or repair work, next to inspection the most important problem is safety. Whenever any machine is being inspected or repaired, a workman should be appointed as safety observer, who during the performance of the job watches for any unsafe practice, not forgetting goggles, locks, tags and belts when working on movable or stationary machines.

DISCUSSION

PRESENTED BY

C. E. S. EDDIE, Plant Lubrication Engineer, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

W. L. KIRK, Electrical Engineer, The Detroit Edison Company, Detroit, Michigan

J. A. SHIMMIN, Superintendent of Maintenance, Rotary Electric Steel Company, Detroit, Michigan

T. J. VAN TUYL, The Detroit Edison Company, Detroit, Michigan

C. H. WEIHE, Hudson Naval Ordnance, Detroit, Michigan

A. W. MOHRMAN, Turn Foreman, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

W. E. REIBER, Assistant Chief Electrician, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

C. E. S. EDDIE: I would like to substantiate some of the things Mr. Reiber has said. He mentioned this business of education in electrical work; I also want to say that these fellows in electrical departments are doing more than studying electricity. I had the privilege of teaching one of the classes this past winter, and believe me, when I got through with the ordeal, it seemed that they knew more about applied lubrication than the teacher.

Lubrication, from our point of view, can't be stressed any too strongly. It has been said by the experts that if a thing is properly lubricated, it just doesn't wear out. There is one thing that has been troubling me ever since Mr. Kirk spoke on transformer maintenance. He has given me the idea, or belief, that the conditioning of transformer oil is not necessary. Even with all of the gadgets and all the precautions he has taken to keep the oxygen, condensation, etc., out of the oil, I do think it is necessary to condition the transformer and switch oil, and I would like to ask Mr. Kirk what procedure they have in conditioning oils for this service.

W. L. KIRK: That isn't the impression I wanted to leave. I meant to say that by keeping the oxygen and the water out of the oil, we do lessen it to a very little quantity of oil as far as transformers are concerned. We do a lot of processing of oil, most of which comes from circuit breakers; very little comes from the transformer itself. We check the oil both as to power factor and acidity. Although we have those in our company who are acid conscious with oil, we have very little trouble from acid content in oil at the present time.

We do refine oil, lots of it, by a processing method, and we have special machines for that particular purpose. We refine two or three thousand gallons of oil a week, but as I said, most of that comes from circuit breakers and a small percentage from transformers.

Every bit of oil we handle, whether it is from circuit breakers or from transformers, we put through a centrifuge and also a blotter press to take out carbon and water that may be in the oil.

We do recondition oil. I am sorry if I left that impression. The thing I wanted to impress upon you was that we do very little handling of transformer oil itself, due to the fact that we protect the transformers, and the majority of the handling is on oil from circuit breakers and quite a bit on older installations.

J. A. SHIMMIN: As I understand it, you do not have a routine set up, for conditioning the oil every five years or ten years?

W. L. KIRK: No. We have transformer oil we haven't filtered for 20 years.

T. J. VAN TUYL: I think one thing that should be brought out is that Mr. Kirk was talking about large transformers with conservator tanks and nitrogen gas to make up for expansion and contraction of oil. In smaller size transformers that breathe air and moisture, the problem of maintaining oil by filtering needs to be taken care of more frequently.

W. L. KIRK: When I started out, I tried to emphasize the fact that it was large transformers. In smaller transformers which take in moisture and all the other things in the atmosphere, you are bound to have a certain amount of trouble with the oil, and that should require considerable more maintenance.

I brought out the point that in places which have

(*Please turn to page 90*)

CONSERVATION OF *Critical* MATERIALS FOR *Electrical Equipment*

. . . . even war, which is a process of destruction and a tremendous waste of materials, can teach us a lesson of economy, of wiser use of our materials, a lesson of good engineering . . . . it is for all of us to learn this lesson . . . . we are paying plenty for it . . . .

by L. A. Umansky, ASSISTANT MANAGER
INDUSTRIAL ENGINEERING DIVISION
GENERAL ELECTRIC COMPANY
SCHENECTADY, NEW YORK

▲ IT IS probably unnecessary to say that conservation of critical materials is needed — in fact, it is imperative — to further our war effort. It certainly came as an unpleasant surprise to many of us, used as we were to the idea that this was a land of unlimited resources, that for the task on hand even our resources were limited. Furthermore, the fortunes of war have deprived us, either fully, or in part, of many indispensible materials around which our industries have been built.

Thus the electrical engineers, just like all other engineers, are put face to face with the problem of how to stretch our supplies, how to make one pound of copper, or rubber, or any other scarce material, do the work of two pounds. This problem is not — at least it should not be — new to engineers. After all, the old definition of an engineer is that of a man who can get needed results for a dollar instead of the two dollars required by others. This is, in substance, what we are expected to do in war time; only we should realize that in the economy of scarcity the dollar is not always a true yardstick of accomplishments. To save a pound of copper may be more important than saving a pound of silver even though silver may be 60 times more expensive.

With this background briefly sketched, let us see what we can contribute to this effort.

The electrical manufacturers certainly have a hard task on hand. They obviously want to maintain the quality of their products, if for no other reason than because the fixing of a breakdown, and the adjustment of a complaint is the most expensive procedure conceivable. When a piece of equipment fails on an important job, it would be a poor excuse all around to claim that this failure is unavoidable simply because we have to conserve some critical materials.

SCARCE MATERIALS

What materials are scarce in electrical manufacturing? This list is long indeed.

Alloy steels, including stainless steel, are hard to get, as you well know. Combat equipments of all kinds get the first call on this material, even though our capacity to produce it has increased fourfold in the last three or four years. This means that the more readily available low carbon steel should be substituted in many instances. For the same strength more weight is then required, unless by skillful changes in the design this extra weight is eliminated.

Aluminum stands high on the list of critical materials for reasons obvious to all. Its uses in electrical equipment were many and varied. Cast aluminum squirrel-cage rotors could be, of course, substituted by copper bars; but copper is just as scarce, and making rotor copper winding would require far more labor which is getting to be the scarcest material of all. No other good substitute has been found yet, and the rotors are, by and large, still made with cast-aluminum, except that

Presented before A. I. S. E. Detroit District Section Meeting, January 12, 1943.

reclaimed aluminum, not suitable for airplane construction, is being more widely used.

In many control and switchgear devices, aluminum was used to get light weight of moving parts or to obtain an easily manufactured design such as die-casting. Many of these moving parts are now made of steel — and to maintain the low weight, the design had to be modified, putting an extra burden on the engineers and draftsmen. Zinc die-castings are widely used as substitutes. By these and similar steps, one electrical manufacturer alone has reduced his annual consumption of aluminum by seven to eight million pounds.

The shortage of tin has hurt us primarily in the manufacture of bearing babbitt. Our pre-war standard called for a composition containing 83⅓ per cent tin. Intensive work was carried on to find a high-grade lead-base babbitt. Finally, such alloy has been found containing 82½ per cent lead, 15 per cent antimony, 1 per cent tin, 1 per cent arsenic, ½ per cent copper. In this manner, 200,000 lb or more of tin per year is being saved.

I will not take too much of your time in describing the substitution of other critical materials, such as chromium, nickel and non-metals like toluol — ingredient of many insulating varnishes — together with tung oil, shellac, mica, etc. I will draw attention to the most important ingredient of all, namely, copper, without which the electrical industry could not exist at all.

COPPER

In a "normal" prewar year, we have used in the United States an average of three to four billion pounds of copper, i.e. up to 2,000,000 tons, annually. (Compare this with our present annual steel making capacity of about 90,000,000 tons.) About 40 per cent of this copper has been used for current carrying purposes, i.e. in electrical machinery, transmission and distribution lines, radio, and telephone and telegraphs.

The domestic production of copper has not been materially increased since that time, for various reasons, some of which are unavoidable. The imports of copper, primarily from South America, are subject to shipping difficulties. Thus, our supply of copper is definitely limited. At the same time, the amount of electrical apparatus manufactured has more than doubled, and the copper requirements for other war material have grown by leaps and bounds. Hence, the strictest economy is plainly indicated and should be rigidly enforced.

Let us establish clearly in our minds what the saving in copper in the electrical equipment means for our war effort. We are so used to having an abundant supply of all materials on hand, that a saving of, say, one ton of copper in a large project may sound picayune and not worth the engineer's time. What is a ton of copper? 2000 lb at, say, 12 cents a pound is only $240. But, these 2000 lb will make 80,000 cartridge cases for machine guns. I will let you estimate yourselves how much the end of war will be approached if these rounds of ammunition were fired at the enemy. We see, therefore, that it is not the cost of copper, but its availability that counts. The cost alone is a poor yardstick to measure our effort in wartime.

SILVER AS COPPER SUBSTITUTE

Can we substitute copper by another current-carrying material? Aluminum can be readily used for buses, cables and, as we have seen, in squirrel cage motors. However, its conductivity is less than that of copper; one cannot, therefore, simply make an aluminum coil for an electric motor, or a contactor, etc. and expect that it will go into the available space without affecting the performance. A radical redesign of all apparatus would be needed, a task of appalling magnitude and, therefore, not readily feasible, particularly in wartime. Furthermore, aluminum production is already mortgaged for aviation. In a few cases, some bus bars were successfully made of steel and this practice will undoubtedly grow, and should be encouraged but the total saving is rather limited in scope.

Some spectacular use of silver instead of copper has been made and should be dealt with at some length. Silver is an excellent conductor — some 6.4 per cent better than copper. It can be readily used, if available, instead of copper, without changing the design of the apparatus.

In normal times, the cost of silver would make its wide use as an electrical conductor prohibitive. At, say $8.00 a pound, as against 12 cents for copper, the economics of the subject are obvious. The use of silver was, therefore, limited to such parts as contacts of breakers and switches, and the like.

This economic balance was upset by the war. Rightly or wrongly, the government policy for the last several years has been to buy on the market, and at a lucrative price, all silver mined in the country. This silver was then stored in the vast vaults at West Point, without the government having any right to sell it on the market for commercial uses. However, nothing in the law prevented the government from loaning this silver, maintaining its title to it, for a war plant. This interpretation of the law was utilized and a common sense decision made, as the following example will show.

To increase the supply of aluminum and magnesium, a large number of so-called electro-chemical potlines were built wherever power was available. One should remember that this process requires 10 kwhr per lb of aluminum produced (i.e. about 20,000 kwhr per ton, as compared with less than 200 kwhr per ton of steel). In 1943, the production rate of aluminum will be over 2 billion pounds per year, which means that 20 billion kwhr will be used to make aluminum from aluminum oxide; this is even more energy than will be consumed by the entire steel industry.

A typical "potline" may require 60,000 amp at 650 volts. This power is provided by twelve 5000 amp arc rectifiers (Figure 1), served by six transformers. The 60,000 amp d-c current is collected by a heavy bus and carried to the electrolytic cells. This bus, if made of copper would weigh about 1000 tons. This amount was saved on each of the several potlines by making the bus out of silver. I will let you figure out for yourselves the number of rounds of ammunition made possible by this step.

Interesting as this experiment is, we should not look to silver as an answer to our problem. Our supply of silver is large, if measured by conventional silver standards, but it is a drop in the bucket as compared

with our annual copper production. In other words, we still depend on copper to carry current. The problem of stretching our limited supply is still with us. This is the major problem for both the electrical manufacturer and you, as users of electrical equipment.

SAVING COPPER IN ELECTRICAL MACHINERY

What can we — you and I — jointly do to make this problem easier?

The first step has been already pointed out to us by the WPB. I am referring to the recent order instructing, among other things, the use of electric motors above their nameplate rating. Thus, you are urged to use a 20 hp, 40 C motor on a 25 hp job. For totally enclosed, fan-cooled, a-c motors, 10 per cent overloading is recommended, while for open d-c motors, 15 per cent.

A steel mill man abhors selecting undersized motors because he knows of so many cases when even a normally selected motor was heavily overloaded shortly after being put in service. Now, he is invited to wipe out any margin he might have had up his sleeve. Throughout my own steel mill days, I have preached and practiced the philosophy of liberal margins in selecting motor sizes; of considering this margin as a prudent investment. I still believe in this approach in normal times. But, we have no choice in the matter, not because WPB made this rule, but because we would and should make this rule ourselves after considering the wartime national interests.

Figure 1 — Typical rectifier installation in an electrochemical plant including twelve 5000 amp, 650 volt units. By making the 60,000 amp bus out of silver, about 1000 tons of copper can be saved at such "potline."

It is true that an overloaded motor will not last as long as one normally selected. Its life may be cut down in half, say from 20 years to 10. But we can build more such motors with the materials on hand, and, therefore, can equip more war plants or more shops. This should be our single purpose. We are concerned with a struggle for national survival, not with financial investments, prudent or otherwise.

It is perfectly obvious that common sense should guide us in this line, as always. If, for instance, the capacity of the motor drive is determined by the maximum available torque, and not by the continuous capacity, then the torque value should be checked before recommending a reduced size motor. The war effort will not be furthured by a motor which will not permit the driven machinery to produce the maximum amount of war material.

There are many other ways in which copper may be saved in building electric motors even without impairing in the least the reliability and durability of the machines. These remarks apply primarily to large, tailor-made machines such as are used for driving rolling mills.

It has been the generally accepted custom to specify and to build 40 C motors with class A insulation, the temperature rise being contingent on open, self-ventilating operation. Now, if we consider a large d-c motor, and leave its armature as is, but equip the field windings (shunt, commutating and pole-face) with class B insulation and then allow a 60 C rise on these field windings, we can save, on the average, 20 per cent of machine copper. For instance, on a 2000 hp, 250-500 rpm motor, 1500 lb of copper can be saved; on a 4500 hp, 125-250 rpm motor, 3500 lb of copper can be salvaged for war uses. Please remember, this saving will not impair in the least the reliability of the machine. Certainly, a 60 C rise for class B insulation is more conservative than 40 C for class A; a steel mill man goes even to 75 C rise on mill type auxiliary motors, which he is using on most responsible jobs in preference to industrial type, 40 degree machines. But when it comes to large machines, this plain fact has to be argued anew. Yet five machines, instead of four, can be built under this plan out of the same amount of copper.

Forced ventilation as means of getting full capacity out of a motor has not been accepted universally by the steel mill community. For a non-reversing drive, like that used on a hot strip mill or a merchant mill, many engineers still insist that the drives should be built for a 40 degree open, non-ventilated rating. The extra capacity obtainable due to ventilation is kept as an extra margin, since the ventilating equipment "may fail sometime." There is little justice in this argument; the most responsible drives such as for reversing blooming mills cannot operate without forced ventilation, and this fact is accepted as a law of nature. Many cold strip mill motors, which have to be designed for very low inertia, are also contingent on forced ventilation for their rating. It is perfectly logical to extend this practice to all mill drives and save the needed copper.

Here is another example of sound engineering applied to save critical materials. A 35 in. reversing blooming mill is driven by a 4000 hp, 50-100 rpm motor, supplied with power from a 3500 kw motor generator. The latter is, in turn, driven by a 4900 hp synchronous motor. Now, the peak loads on such mills go up to 275 per cent of normal rating; the synchronous motor should be designed not to pull-out under such peak loads. It has been the practice to design such motors for 80 per cent power factor at rated load, to operate them at constant excitation and to require a pull-out torque of 275-300 per cent. This is rather poor engineering. The duration of all

peak loads, added up together does not constitute more than one per cent of the total operating time. To operate such motor with constant excitation, designed for peak conditions, means an oversized machine, with very much higher losses; it will also cause wide fluctuations of reactive kva and power factor on the line. Instead of this, the equipment in question was built with a special excitation system, whereby the motor field was automatically adjusted as function of load, with the power factor remaining substantially constant.

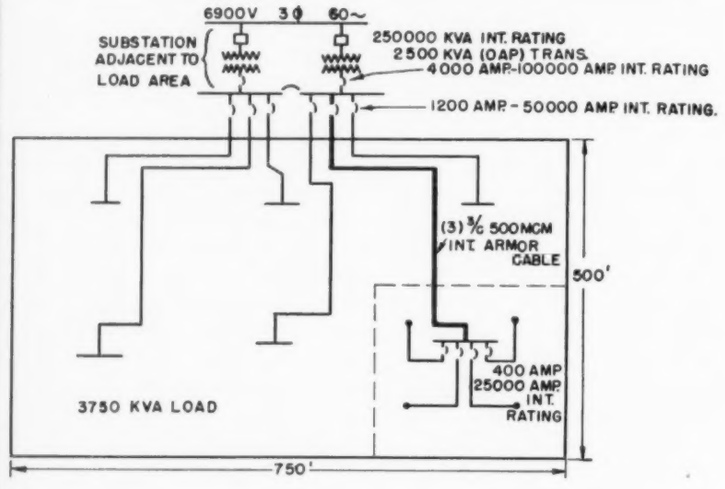
Overall efficiency has been raised. The voltage disturbances on the system, due to rapidly fluctuating load, have been greatly reduced. Best of all, a ton of copper can be saved on a motor of this rating. And we get a better all-around job.

COPPER SAVING IN POWER DISTRIBUTION

But the greatest contribution to copper saving which you and I together can make pertains to the field of power distribution. After all, the engineers designing motors, or transformers, or any other piece of apparatus, were always striving to get the most out of each pound of material that went into their product. Try, for instance, to put more copper than you need into an a-c motor; sure enough you then might reduce sometimes the copper losses — but, at the same time, you are apt to spoil the other motor characteristics, such as starting current, power factor, etc. You see, the apparatus design is a well balanced proposition and a lavish but unwise use of materials may give you the results opposite from what you might expect Thus, I repeat, in the apparatus design field, it is possible to save some of the critical materials used; but this reduction cannot be too spectacular in the grand total for a specified horsepower, speed or voltage of the machine. On the other hand, the problem of distributing power economically — particularly the low voltage or utilization voltage such as 440 volt, a-c in industrial plants has not been stressed sufficiently until the last couple of years.

Let us see how we used to provide this low voltage a-c supply. We would install a large capacity transformer bank — say 2000, 3000 or 5000 kva — for an entire plant, (see Figure 2), or for a large area of our plant, and we would then distribute the low voltage power throughout this area by heavy feeders. In the days of abundance, we did not hesitate to carry large blocks of this low voltage power for distances of 1000-1500 ft; if voltage drops were excessive, we would not hesitate to string along more cables. I am quite confident that the greatest copper "mine" in the world is buried in low voltage systems of our plants.

Common sense and war necessity have changed this practice of late. We endeavor to bring high voltage power to local load centers, (Figure 3) and then step-down to utilization voltage in relatively small or medium sized blocks. This means, of course, that the step-down transformers should be located at the load centers, which may mean in the working area. This can be readily done by using transformers filled with non-inflammable liquid or equivalent.


6900V 3φ 60~
SUBSTATION ADJACENT TO LOAD AREA
250000 KVA INT. RATING
2500 KVA (OAP) TRANS.
4000 AMP-100000 AMP INT. RATING
1200 AMP - 50000 AMP INT. RATING.
(3) 3/C 500MCM INT. ARMOR CABLE
500'
400 AMP 25000 AMP. INT. RATING
3750 KVA LOAD
750'

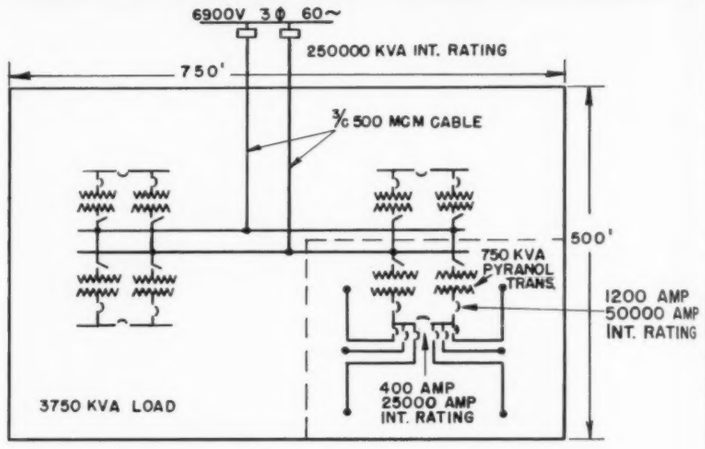


Figure 2 — Old-fashioned way of supplying low voltage power to the plant. Step-down transformers are located at the boundary line and lower voltage feeders are long and wasteful of copper.

Figure 3 — A better way of distributing power through the same plant as in Figure 2, but by using smaller transformers located at the load centers. Copper is saved, first cost of the distribution system is reduced, and better performance is secured.

This method has been almost universally adopted by most of the war plants which sprang up into being in the last one or two years. Figure 4 shows such transformer substation, consisting of two three-phase transformers located in pairs and throat connected to a metal-enclosed 440 volt switchgear. The transformers are connected to alternate high voltage feeders, so that an uninterrupted service may be readily assured when needed.

Of course, the total installed kva capacity and the cost of the transformers is increased. On the other hand, the cost of cables is greatly reduced. Also, with local transformers of limited capacity, the interrupting ca-

Figure 4 — Typical 480 volt unit substation for load center distribution.

pacity of the secondary switchgear — and, therefore, its cost — is very much lowered.

An analysis has shown that there is a most economical balance between these several factors. Figure 5 indicates that, for 440 volts, the most economical transformer size is somewhere between 600 and 1000 kva, and is practically independent of the load density, as shown by the several curves. The cost of "distribution system" includes the high and low voltage switching, cables and transformers. You will note that this cost is around $20-$25 per kva of the system capacity. By the way, the transformer cost is only $3-$4 per kva, so you see why, by increasing the installed capacity of the transformers, we have not affected the results to a large extent.

Now, let us get back from dollars to pounds of copper. The point which I want to make is that the distribution system is the place where most of the copper saving can be made. Assume a large plant — a wartime plant, if you please, or any plant for that matter — with high voltage power brought to it and then stepped-down to motor voltage. We assume that the bulk of the load is a-c. As to the steel mill d-c load, we will deal with this problem separately. Assume that the total installed motor capacity is 10,000 hp (mostly in squirrel-cage motors. 7½-10 hp average) and that with a 40 per cent diversity factor, the plant load is about 4000 kva; the distribution system is designed for this latter capacity.

An average induction motor of this capacity requires not more than two to three pounds of copper per hp, for both stator and rotor. If aluminum is used for the squirrel-cage rotor, about one-third less copper is needed. For larger motors, even less copper per hp is required. On the other hand, several times that amount of copper is needed to bring power for each hp of the installed motor capacity. For instance, in our typical case:

(a) If 440-volt motors are used and the high voltage power is brought to several step-down substations located near the load centers, up to 5 lb of distribution copper might be required per each hp installed.

(b) If, on the other hand, an old-fashioned distribution system is employed, with a single step-down substation and with power being distributed over a large area at 440 volts, then as much as 9-10 lb of copper might be used per hp.

(c) Worse yet, if 220 volt motors are chosen instead of 440-volt (this does not affect the amount of copper used in the motors themselves) the distribution copper will go up to 10 lb per hp if load center substations are used and up to 18-20 lb per hp if an old-fashioned system is chosen.

If we compare the best and the worst of these distribution systems, we will readily see that by good engineering as much as 150,000 lb or 75 tons of copper can be saved for this plant. This is enough to make 6,000,000 cartridges for a machine gun. And, incidentally, a better power system will have been provided.

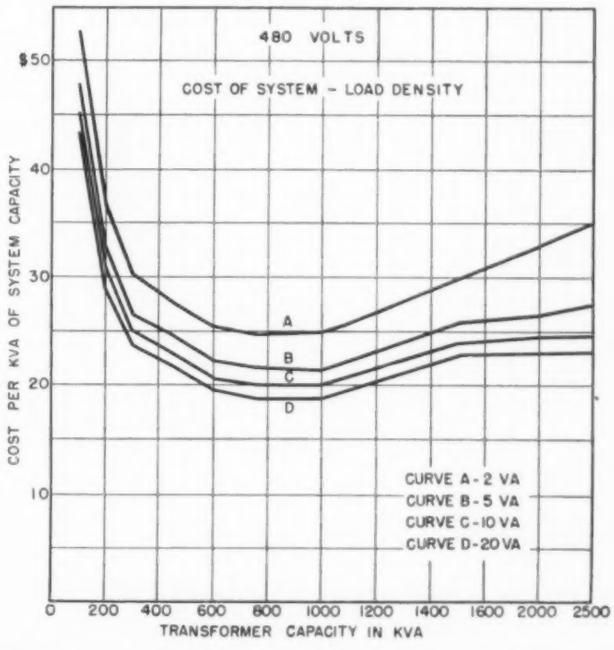
These figures might change (usually upward) depending on plant size, load density, etc. But the order of magnitude of relative allocation of copper as given above, is conservatively correct.

There is little, if any, excuse to consider 220 volts for low voltage a-c motors. The experience of many first class plants, and for many years, has proven beyond any reasonable doubt that the 440 volt motors and control are fully as reliable — and as safe to personnel — as the 220 volt equipments.

LIGHTING SYSTEM

The next point to consider in a new plant — or in an extension of an existing plant — is the lighting system. A vast amount of critical material can be saved and a

Figure 5 — This curve indicates that for 480 volt distribution the most economical size of load center transformers is 600-1000 kva at practically all load densities (between 2 and 20 volt-amperes per sq ft of area).



better system can be provided if enough attention is given to this subject and some conventional ideas are critically reviewed.

Fluorescent lighting is now recognized as a reliable and most economical system for indoor use. It is justified by power economy. Incandescent lighting would require more than twice the power for the same illumination level. When it is recognized that for each kva delivered to the utilization device, a material investment in electrical system consists of 25-50 lb of copper and 150-400 lb of steel, the economy of fluorescent lighting is self-evident.

A four-lamp, 265 volt fluorescent unit is available. Hence, it is not necessary to limit the lighting circuits to 120 volts, or even to 120-240 volts. This alone is a gain. But a further advantage is available, by combining the power and lighting systems and by using a four-wire, 480-277 volt distribution for motors and lights.

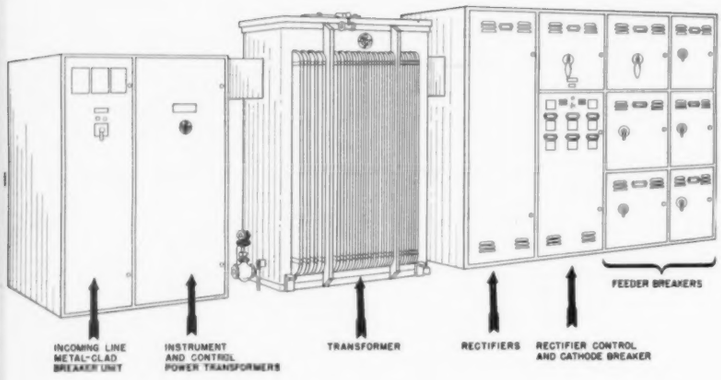


Figure 6 — D-c unit substation with a sealed rectifier for supplying 250 volt power at load centers.

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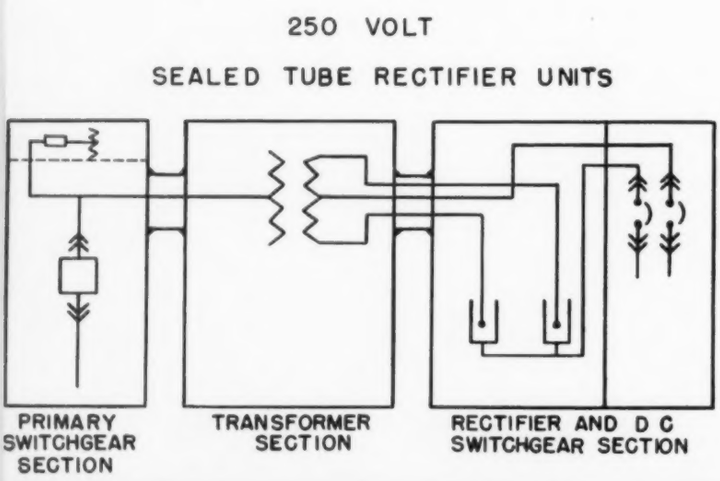
Figure 7 — Power circuit diagram of a rectifier unit substation.



To illustrate the economy of this method and the resultant saving of materials, a hypothetical case will be analyzed. Assume an area of 350 x 350 ft (122,500 sq ft), and allow two volt-amperes per sq ft for fluorescent lighting and six volt-amperes per sq ft for motors, i.e. a total of 250 kva for lights and 750 kva for power. This load can be taken care of in one of the following manners:

A. Provide common three-phase load-center transformers for motors and lights, and feed them directly from 480-277 volt, three-phase, four-wire circuits.

B. Provide common three-phase, load-center transformers, distribute this power by three-phase, 480 volt feeders, but supply lights from these feeders through intermediate small (25 to 75 kva) transformers, stepping-down from 480 volts to 120 volts at the lights.

C. Provide three-phase, 480 volt load center transformers for power, and independent 120 volt or 120-208 volt load center transformers for lights, both kinds of transformers being supplied from high voltage feeders.

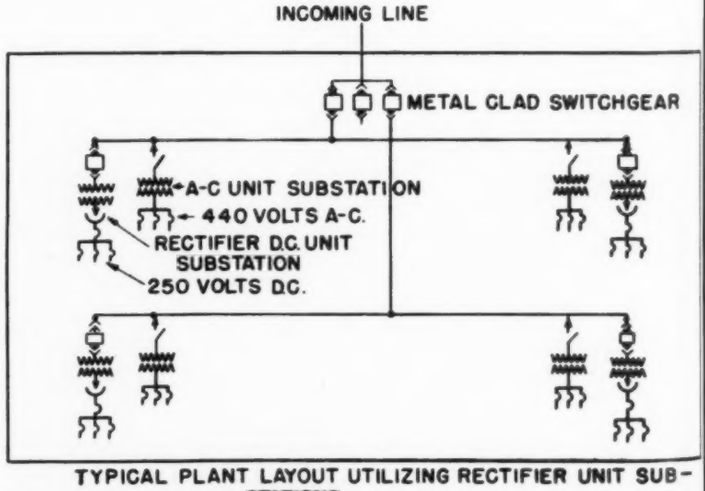
It will be noted that in all three cases the fluorescent lighting was assumed. Such differences as will be pointed out are based on the method of distribution only.

If the copper requirements for lighting distribution in the case A is 100 per cent, then they are 140 per cent for case B, and 145 per cent for case C. The steel requirements are 100, 155 and 160 per cent respectively.

We can conclude, therefore, that for the general plant lighting a common 480 volt system for power and lights, with separate feeders for lights, will rapidly gain the general acceptance.

Undoubtedly, a relatively small amount of 120 volt a-c supply will be needed for drop lights, portable tools and the like. It can best be provided by local 480-120 volt transformers of 5, 10 or 15 kva capacity.

Figure 8 — Power distribution system for supplying 480 volt a-c, and 250 volt d-c to an industrial plant.



TYPICAL PLANT LAYOUT UTILIZING RECTIFIER UNIT SUBSTATIONS

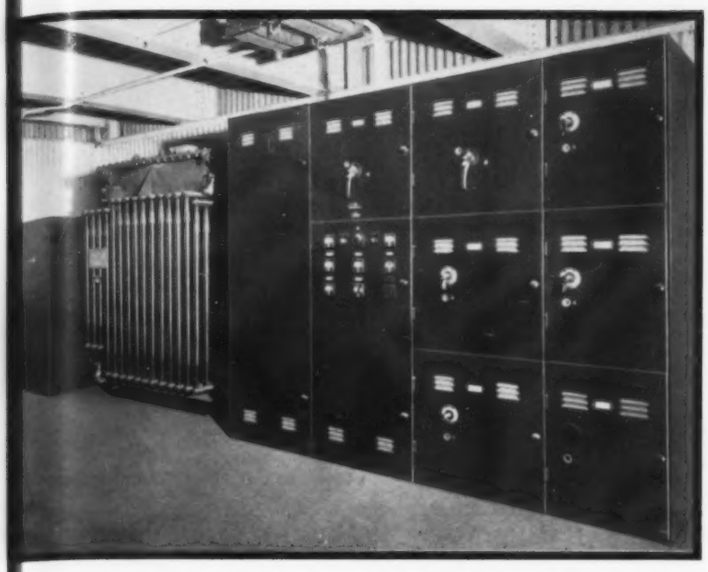


Figure 9 — Front view of a 300 kw, 250 volt sealed rectifier substation installed in a war plant.

D-C POWER SUPPLY

Some d-c power supply is needed in almost any industrial plant. For a steel mill, it is the very life blood, without which the mill could not function. Have we provided in the past this d-c power economically? Can we save critical materials by applying the same methods which gave us such good results in a-c distribution? The use of rectifiers has pointed our way.

Until last year, the conventional and accepted method was to install one or several relatively large motor-generator sets in a centrally located substation and then distribute the 250 volt power over a large area. For a steel plant, many such substations would have a capacity of 2000,3000 or 4000 kw; feeders 1000-2000 ft long were not uncommon. There were good reasons to provide this arrangement. The motor-generator sets should be, preferably, housed and attended. By banking the several sets together the installation cost and cost of attendance was reduced, while the IR drop of long feeders was easily compensated by more copper in the cables.

The first 250 volt rectifiers applied in steel industry were again of the same capacity — 1000 or 1500 kw — as the motor generators. These rectifiers have proven conclusively that they are well suited for steel mill conditions and this fact is now too well recognized to be argued. However, in these installations, the rectifiers have merely replaced the motor-generator sets, but have not affected the power distribution. This was the next step to take. The thought occurred to us that load center d-c substations could be provided as readily as for a-c distribution. Such were designed and built, in capacities up to 500 kw, 250 volts.

Figure 6 shows this arrangement. At the left, we have the primary switchgear. Next comes the transformer with non-inflammable liquid. Next is the rectifier cubicle with sealed ignitrons and the d-c switchgear which can be extended to include any number of feeders required. Figure 7 shows the power circuit.

Several possible arrangements are possible. The primary a-c switchgear may not be located adjacent to the rectifier but in the lineup with other a-c gear elsewhere; in this case merely a pot-head is required at the transformer.

Figure 8 shows a typical system layout whereby the a-c and d-c unit substations are both located at the load centers. The similarity between them is quite apparent. This construction permits building of the d-c substation complete at the factory and of easily installing it at the destination. The transformer is usually self-cooled. The rectifier includes sealed ignitrons, permanently evacuated at the factory, obviating the need of vacuum pumps. The rectifier is water-cooled, tap water usually being satisfactory for this purpose.

More than 100 such equipments were built or are on order with one manufacturer alone, since this idea was

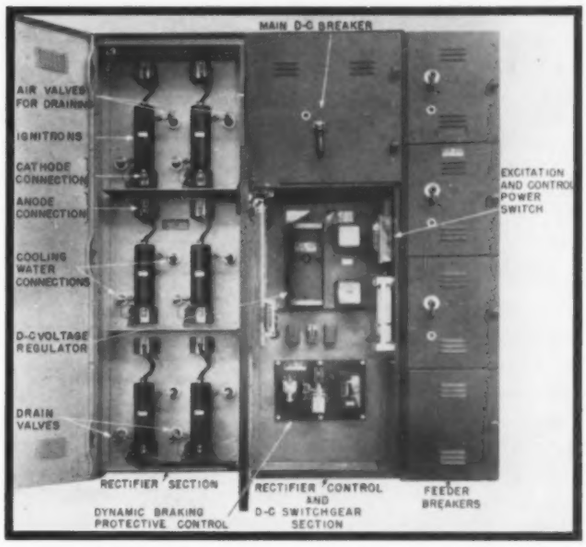


Figure 10 — Close-up view of a 300 kw rectifier compartment with door open, showing the six sealed ignitrons.

brought out about a year ago. Most of these rectifiers are installed in various war plants. Figure 9 shows a 300 kw unit of this kind, consisting in this case of a transformer, rectifier and d-c switchgear; the primary a-c switching is located elsewhere. On Figure 10, we can see a similar equipment with the front door of the rectifier compartment open and the six ignitrons clearly shown.

What is the principal advantage of these rectifier stations? Why have they spread out so rapidly in the course of only one year? First, we must recognize the fact that the factory facilities to build motor-generator sets, of all manufacturers, are heavily taxed by defense orders. You must have a motor to propel an electrically driven ship or to drive a mill rolling ship plates, and usually the same manufacturing facilities can be employed to build these motors as to build the motor-generator sets. Rectifiers provided the answer to this phase of the problem.

Next, the rectifier equipments require less critical materials. On the average, more than 20 per cent

copper and 40 per cent ferrous metals can be saved as compared with rotating equipment. The full-load efficiency of a rectifier is 3-4 per cent higher than that of a motor-generator set; at light loads this advantage is even greater.

But here, again, the main advantage will be in the distribution end. The sealed rectifier which permits the totally enclosed, unit construction, gives us the chance of moving the source of d-c power to the load centers. D-c feeders will shrink in size. Copper saving will be of very large magnitude.

At the time of this writing, none of these rectifier unit substations are installed in a regular steel mill. There is absolutely no sound reason why their use should not become very wide in the near future.

WARTIME CHANGES WILL AFFECT OUR PEACETIME PRACTICES

The several wartime trends and developments which we briefly have covered will stay with us after the war is over. We will review and revise many of our pre-conceived ideas. The steel mill of tomorrow may be quite different — even at the electrical end — from what we have considered only yesterday as a good and "standard" practice.

May I ask your indulgence to sketch briefly my conception of the electrical system of a large steel plant built in five years from now, or even sooner? In the first place, the main high voltage distribution voltage will be undoubtedly higher than 6600 volts. Several large plants have already adopted 11 kv as a better voltage and either this voltage or even 13.2 kv will be recognized as most desirable for several good reasons:

(a) Cable cost will be reduced.
(b) Short circuit currents will be reduced in magnitude and this is quite a problem for a large plant with say 100,000 kw generating or transformer capacity.
(c) The available switchgear used now for 6600 volts is designed and is suitable for the 15,000 volt level.
(d) Large motors, particularly synchronous, can be readily built for this high voltage.

Of course, it will be necessary to fill in the gap between, say, 11,000 volts and 440 volts, for motors of medium size; 2300 volts can be readily supplied by local unit substations, without providing a 2300 volt network for the entire plant. This will take care of motors from, say, 300 hp to 2000 hp. (It should be clearly understood that I do not advocate the use of a 2300-volt power distribution system or network for the entire plant. Too many plants having such a system are rightly considering it as a curse, and with this view I heartily agree.)

Load center transformer stations of not more than 1000 kva, stepping-down from 11,000 volts or 13,200 volts to 480 volts, will take care of the smaller motors and of the lights.

Individual 250 volt d-c substations with sealed rectifiers will be used at the load centers to supply the constant potential d-c requirements. The capacity of each such rectifier will not exceed 1000 kw, and might only be 500 kw.

The capacity of the constant potential d-c system will probably be smaller, relatively speaking, as compared with present steel mills. A greater number of special drives will be provided with Ward-Leonard type of control, i.e. this load will be transferred to the a-c distribution system.

Many large d-c main drives of non-reversing type, such as for hot strip mills, merchant and rod mills, etc. will be supplied with d-c power by rectifiers, providing a substantial speed range by voltage control.

It is always risky to forecast the future, particularly the none-too-distant future. In five to ten years from now, all of us, let us hope, will be alive and in good health, and my predictions can be then readily checked. This is a chance which I must take!

DETROIT *Discussion*

(*Continued from page 82*)

several large size transformers, oil conditioning is seldom required. We haven't touched the oil in the transformers at Great Lakes Steel Corporation since 1929, when they were first put in. That is one case out of perhaps two hundred, but in small transformers we do have oil conditioning. We don't have any routine set up for checking them, but it is taken care of in the regular maintenance work. But some distribution transformers have been set up for years and years, and we have never filtered the oil in them.

C. H. WEIHE: Relative to the transformer oil problem, is the oil checked at certain periods by drawing samples for test from transformers in sizes of 100 and 200 kva?

W. L. KIRK: We make periodic tests of all large transformers every six months. Then if any particular thing shows up, we go into the measure of power factor and acidity, and the dielectric. Of course, we take these dielectric tests every six months. But on these 200 kva jobs, we do not make periodic checks on small transformers.

C. H. WEIHE: Do you think they will run five or ten years without inspection? Is it considered good practice?

W. L. KIRK: We have had them run longer than that. I don't want to leave the impression that we don't pay any attention to oil. We do, but in the small transformers, we do not give it the particular attention that we do the large transformers. If a small transformer would go up, the question of service would be very small, whereas a large transformer would involve a great deal more.

A. W. MOHRMAN: On the question of welding conduit, we sometime ago built a crane at our plant and in wiring the crane, we welded the conduit. I would like to ask Mr. Reiber how that application held up. Has there been any trouble or did the conduit break loose due to vibration?

W. E. REIBER: So far no trouble has developed. We have practiced from time to time the welding of conduits in lots of jobs that turned out to be permanent. I might state that we have made a practice of welding conduits during the last five or six years.

J. A. SHIMMIN: Is that welded for purposes of hanging it up or for purposes of continuity?

W. E. REIBER: Putting it in position.

As 1943 proceeds with encouraging reports on the progress of our armed forces on the global battlefields, we in industry must beware of over-confidence and false optimism. We must work on with unrelenting vigor to keep war materials flowing from our plants in even greater volume. We can ignore no opportunity to improve our product and increase our production. It is with this in mind that I wish to invite the engineering and operating men of the iron and steel industry to take part in the annual meeting and engineering conference of the Association of Iron and Steel Engineers.

J. E. Flynn

President

PROGRAM

Annual Meeting and Engineering Conference

ASSOCIATION OF IRON AND STEEL ENGINEERS

WILLIAM PENN HOTEL - PITTSBURGH, PA.

SEPTEMBER - 28 - 29 - 30

PRESIDING OFFICERS and A

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E. J. POSSELT

C. L. McGRANAHAN

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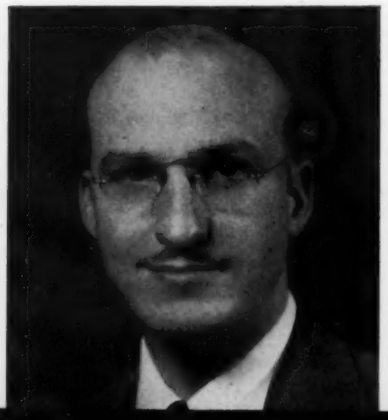
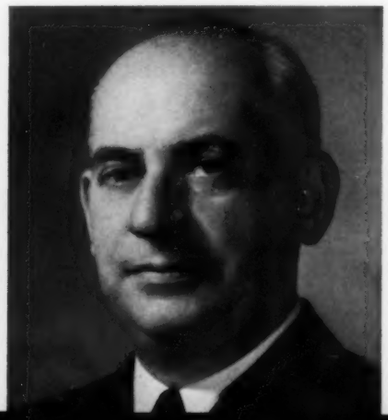
C. A. GETZ

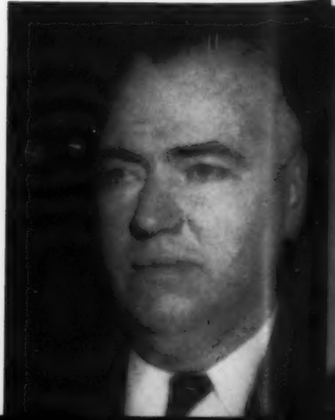
HERMAN ULLMER

J. F. WILBUR

A. C. C







AUTHORS at CONVENTION

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H. W. NEBLETT

F. H. DYKE

H. R. FORD

A. C. CUMMINS

F. MOHLER

H. J. GRIFFITH

C. C. LEVY

Tuesday, September 28

9:00 A.M. — REGISTRATION — Silver Room.

Chairman:
J. S. MURRAY
Chief Electrical Engineer
Follansbee Steel Corporation
Follansbee, West Virginia

Vice-Chairman:
H. W. NEBLETT
Special Engineer
Inland Steel Company
East Chicago, Indiana

9:15 A.M. — BUSINESS SESSION — Urban Room.

Chairman:
F. E. FLYNN
District Manager
Republic Steel Corporation
Warren, Ohio

Vice-Chairman:
F. H. DYKE
Superintendent, Blooming, Bar and Hot Strip Mills
Wheeling Steel Corporation
Steubenville, Ohio

9:30 A.M. — ELECTRICAL DIVISION — Urban Room.

Chairman:
H. R. FORD
Electrical Engineer
Wheeling Steel Corporation
Steubenville, Ohio

Vice-Chairman:
R. W. GRAHAM
Electrical Superintendent
Bethlehem Steel Company
Lackawanna, New York

"Fire Protection in Steel Plants," by C. A. Getz, Director of Research, Cardox Corporation, Chicago, Illinois.

"Robots vs the Manpower Situation," by F. Mohler, Engineer, Steel Mill Section, General Electric Company, Schenectady, New York.

"Relay Protection of Distribution Lines," by L. L. Fountain, Switchgear Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

1:30 P.M. — MECHANICAL AND WELDING DIVISION — Cardinal Room.

Chairman:
F. E. KLING
Assistant Chief Engineer
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

Vice-Chairman:
STANLEYGRAND-GIRARD
Electrical and Mechanical Superintendent
Sharon Steel Corporation
Sharon, Pennsylvania

"Plant Distribution Systems for Oxygen and Acetylene," by Herman Ullmer, Manager, Process Service, Linde Air Products Company, New York, New York.

"Chain and Chain Repairs," by F. W. Shaw, Columbus-McKinnon Chain Company, Tonowanda, New York.

"Prevention of Corrosion in Water Systems," by H. M. Olson, Ohio Salt Company, Pittsburgh, Pennsylvania.

1:30 P.M. — OPERATING PRACTICE DIVISION — Urban Room.

Chairman:
A. S. GLOSSBRENNER
General Superintendent
Youngstown District
Youngstown Sheet and Tube Company
Youngstown, Ohio

Vice-Chairman:
A. D. BRODIE
Superintendent, 93 In. Cold Strip Mill
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

"Industrial Engineering in War Production," by C. P. Spangler, Industrial Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

"Electrolytic Tinning Operations," by H. P. Munger, Superintendent of Electroplating, Republic Steel Corporation, Warren, Ohio.

"Steel for Cartridge Cases," by Lt. R. E. L. Stanford, Ordnance Department, United States Army, Cincinnati, Ohio.

8:00 P.M. — Motion Pictures, selected subjects — Urban Room.

Wednesday, September 29

9:00 A.M. — ROLLING MILL DIVISION — Urban Room.

Chairman:
H. G. R. BENNETT
Engineer, Hot Rolling Mills
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

Vice-Chairman:
JOHN A. SCHOLL
Chief Roll Designer
Tennessee Coal, Iron and Railroad Company
Fairfield, Alabama

"Blooming and Billet Mills and Their Rolls," by F. C. T. Daniels and D. L. Eynon, Mackintosh-Hemphill Company, Pittsburgh, Pennsylvania.

"Some Developments in Plate Mills," by W. A. White, Superintendent of Mills, Kaiser Company, Inc., Fontana, California.

"Bar Mill Arrangement and Pass Design," by R. E. Beynon, Superintendent of Roll Shop Department, Carnegie-Illinois Steel Corporation, South Chicago, Illinois.

9:00 A.M. — COMBUSTION DIVISION — Cardinal Room.

Chairman:
E. C. McDONALD
Combustion Engineer
Republic Steel Corporation
Cleveland, Ohio

Vice-Chairman:
C. J. WYROUGH
Superintendent, Steam Efficiency and Combustion Department
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

"Fuel Oil Systems," by F. C. Frye, Steam and Fuel Engineer, Great Lakes Steel Corporation, Ecorse, Michigan.

"Pitch as an Open Hearth Fuel," by J. F. Wilbur, Superintendent, Fuel and Combustion, Bethlehem Steel Company, Johnstown, Pennsylvania.

Round Table Discussion — Burning the Lighter Oils in the Open Hearth.

1:30 P.M. — ELECTRICAL DIVISION — Urban Room.

Chairman:
J. H. MILLER
Electrical Superintendent
International Harvester Company
Wisconsin Steel Works
Chicago, Illinois

Vice-Chairman:
G. A. KAUFMAN
Chief Electrical Engineer
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

"A New Method of Speed Control and Braking for A-c Cranes," by E. J. Posselt, Engineer, Cutler-Hammer, Inc., Milwaukee, Wisconsin.

"A-c and D-c Drives for Draw Benches and Wire Blocks," by R. A. Geuder, Manager, Metal Industry Applications, Reliance Electric and Engineering Company, Cleveland, Ohio.

"Methods and Equipment for Supplying Power to Steel Melting Arc Furnaces," by C. C. Levy, Industry Engineering Metal Working Section, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

1:30 P.M. — OPERATING PRACTICE DIVISION — Cardinal Room.

Chairman:
A. C. CUMMINS
General Superintendent
Carnegie-Illinois Steel Corporation
Youngstown, Ohio

Vice-Chairman:
C. P. BETZ
Assistant Manager, Hanna Furnace Division
Great Lakes Steel Corporation
Ecorse, Michigan

"Gas Yield and Economy in the Coke Plant," by R. W. Campbell, Superintendent, By-product Department, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

"Modern Trends in Blast Furnace Design," by Frank Janecek, Blast Furnace Engineer, Republic Steel Corporation, Cleveland, Ohio.

"Variations in Blowing Rates for Blast Furnaces," by E. L. Clair, Vice President, Interlake Iron Corporation, Chicago, Illinois.

"Bedding and Reclaiming Metallurgical Raw Materials," by A. J. Boynton, A. J. Boynton and Company, Chicago, Illinois.

7:00 P.M. — INFORMAL STAG DINNER — Ball Room.

Speakers: W. Sykes, President, Inland Steel Company, Chicago, Illinois — "Retrospect and Prospects."
J. T. Whiting, Director, Steel Division, WPB, Washington, D. C. — "Steel After 22 Months of War."

Thursday, September 30

9:00 A.M. — COMBUSTION DIVISION — Urban Room.

Chairman:
P. F. KINYOUN
Combustion Engineer
Bethlehem Steel Company
Lackawanna, New York

Vice-Chairman:
H. C. REESE
Fuel Engineer
Wheeling Steel Corporation
Steubenville, Ohio

"Pulverized Fuel for Heating and Metallurgical Furnaces," by L. S. Wilcoxson, The Babcock and Wilcox Company, New York, New York.

"Colloidal Fuel as a War and Post-War Liquid Fuel," by J. G. Coutant, Fuel Engineer, New York, New York.

"Feed Water Treatment for Weirton's High-Pressure Station," by J. H. Strassburger, Manager, Maintenance and Service, Weirton Steel Company, Weirton, West Virginia.

9:00 A.M. — LUBRICATION DIVISION — Cardinal Room.

Chairman:
P. J. DOYLE
Lubrication Engineer
Republic Steel Corporation
Cleveland, Ohio

Vice-Chairman:
C. E. S. EDDIE
Plant Lubrication Engineer
Great Lakes Steel Corporation
Ecorse, Michigan

"Centralized Lubrication for Blast Furnaces," by A. J. Jennings, General Sales Manager, Farval Corporation, Cleveland, Ohio.

"Lubrication of Non-Metallic Bearings," by G. E. Reiser, Assistant Lubrication Engineer, Bethlehem Steel Company, Lackawanna, New York.

Round Table Discussion — Lubrication Practices.

12:00 — SAFETY LUNCHEON — Ball Room.

Speaker: W. A. Irvin, Director, United States Steel Corporation, and Chairman of the Board of Trustees, National Safety Council, New York, New York.

2:00 P.M. — SAFETY DIVISION — Urban Room.

Chairman:
R. H. FERGUSON
Manager of Safety
Republic Steel Corporation
Cleveland, Ohio

Vice-Chairman:
L. R. PALMER
Conservation Engineer
Equitable Life Assurance Society of United States
New York, New York

"Developing a Practical Safety Program," by A. H. Fosdick, Superintendent of Blast Furnaces, Bethlehem Steel Company, Bethlehem, Pennsylvania.

"Building Safety into the Plant," by H. J. Griffith, Manager of Safety and Welfare, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

"The Responsibility for Safety," by W. Dean Keefer, Vice-President, Lumberman Mutual Casualty Company, Chicago, Illinois.

PRESIDING OFFICERS and AU

J. A. SCHOLL

C. E. S. EDDIE

A. J. BOYNTON

LT. R. E. L. STANFORD

J. G. C

G. E. REISER

H. P. MUNGER

W. A. WHITE

J. S. MURRAY

H. G. R.

A. J. JENNINGS

A. H. FOSDICK

T. E. HUGHES

H. M. OLSON

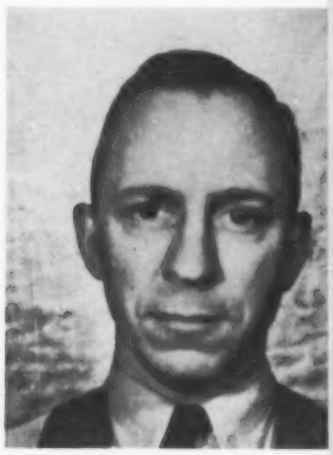
L. L. F

AUTHORS at CONVENTION

J. G. COUTANT

H. C. REESE

E. C. McDONALD



C. J. WYROUGH

H. G. R. BENNETT

F. C. FRYE

P. J. DOYLE

J. H. MILLER

L. L. FOUNTAIN

R. A. GEUDER

R. H. FERGUSON

J. L. MILLER

...put forth your utmost efforts to increase production of steel...

PHOTO BY BACHRACH

WAR PRODUCTION BOARD
WASHINGTON, D. C.

July 23, 1943

IN REPLY REFER TO:
Steel Division
Room 1029
Social Security Building

Association of Iron & Steel Engineers
Empire Building
Pittsburgh, Pennsylvania

Gentlemen:

One of the most powerful weapons against the Axis Nations in the war has been the technical knowledge of the steel industry's engineers and plant operators. This weapon has been in constant use since long before Pearl Harbor. Without it we could not win the war.

Among the heaviest contributors to the unmatched pool of engineering knowledge helping to win the war are the members of the Association of Iron and Steel Engineers, which will hold its annual meeting at Pittsburgh in September.

An event such as this coming meeting is significant in the fight to liberate the peoples of Europe because it represents the free exchange between free men of useful ideas on steel production.

This is a mechanized war and still greater quantities of steel are needed. I urge you to put forth your utmost efforts to increase production of steel from existing plants and from the facilities now under construction and nearing completion.

As Director of the Steel Division, charged with the responsibility of seeing that our country has the steel it needs, I extend to you my best wishes for a successful annual conference.

Sincerely yours,

J. T. Whiting

John T. Whiting
Director, Steel Division

Coke AND By-Products IN 1942

. . . . data from Mineral Industry Survey, M. M. S. 1092, of the United States Bureau of Mines . . . .

▲ THE year 1942 witnessed a new high coke production record for the United States in response to the heavy demand of the iron and steel industry for metallurgical fuel. The total output of byproduct and beehive coke was 70,568,944 net tons, an increase of 5,382,366 tons over the last previous high record in 1941. Of the amount of coke produced in 1942, byproduct ovens supplied 62,294,909 tons and beehive ovens 8,274,035 tons. Byproduct-coke production increased 3,812,487 tons in 1942 compared with 1941, and the production of beehive coke increased 1,569,879 tons. Although the 1942 output from beehive ovens represented only 12 per cent of the nation's total coke production, its contribution to the 1942 war program was noteworthy. Of the 7,309,337 tons of beehive coke produced in Pennsylvania, 6,561,085 tons were used in blast furnaces, mostly in the Pittsburgh district, where pig iron production would have been seriously hampered without the supply from nearby beehive coke plants.

The total value of coke, breeze, and tar produced and of other byproducts sold in 1942 was $629,408,422, an increase of 17 per cent over 1941, and exceeded that of any previous year. The greatest increase was in the value of byproduct coke produced which rose from $316,477,231 in 1941 to $378,011,967 in 1942, an increase of 19 per cent; the value of byproducts sold rose from $158,809,184 to $176,932,465, an increase of 11 per cent for the same period.

The total consumption of coke in the United States in 1942 showed a marked increase when compared with 1941. The principal branch of consumption was in the blast furnaces, and the quantity used by the producers, sold to financially affiliated corporations, or to other companies for blast furnace use was 55,491,570 tons, an increase of 5,037,245 tons over the 1941 figure. Coke used for other purposes (in foundries, for the manufacture of producer gas and water gas, and for other industrial purposes) increased 953,836 tons over the 1941 figure and totaled 9,190,418 tons. Coke sold for domestic use was reported as 6,061,694 tons compared with 6,682,959 tons in 1941. The continued decrease in the quantity of coke used for domestic heating in 1942 emphasized the demand of the iron and steel industry.

Ceiling prices for coke were established by the Office of Price Administration on issuance of maximum price schedules 29, 77, and 121, with subsequent amendments. The average receipts per ton of coke sold by producers in 1942 were as follows: Furnace, $6.16 per ton an increase of $0.53 over 1941, foundry coke $9.75, $0.40 higher than the 1941 price; coke used in the manufacture of water gas, $7.53, $0.79 higher than the price in 1941; other industrial, $6.88, an advance of $0.50 above the 1941 price; and domestic coke, $7.84 an increase of $0.91.

The accelerated rate of byproduct-coke oven operations resulted in substantial increases in the output of gas, tar, crude light oil, and ammonia. The quantity of gas produced totaled 944,879,637 M cubic feet in 1942, a gain of 52,059,826 M cubic feet over the 1941 figure. Crude coal tar output showed an increase of 36,026,151 gallons and reached an all-time record of 740,175,619 gallons. Production of ammonium sulphate or equivalent increased from 1,741,503,884 pounds in 1941 to 1,805,025,721 pounds in 1942. Data on the production of crude light oil and its derivatives are withheld in accordance with government war time regulations.

Production of coke — In 1942 the average daily rate of byproduct coke output increased steadily from 168,700 tons in January to 173,300 tons in December; the average daily rate of beehive remained fairly uniform. The leading states, in order of importance in the manufacture of byproduct coke, were Pennsylvania, Ohio, Indiana, Alabama, and New York. The combined output of these five states equaled 71 per cent of the national production. Pennsylvania was by far the leading producer of byproduct coke and its 16,310,167 tons represented 26 per cent of the total United States production. Pennsylvania, Virginia, and West Virginia led in the production of beehive coke. Their combined output was 96 per cent of the national production of beehive coke.

Statistical Trends of the Coke Industry in the United States

	1923	1939	1940	1941	1942
Coke produced:					
Beehive ..... net tons	19,379,870	1,444,328	3,057,825	6,704,156	8,274,035
Byproduct ..... net tons	37,597,664	42,882,313	54,014,309	58,482,422	62,294,909
Total ..... net tons	56,977,534	44,326,641	57,072,134	65,186,578	70,568,944
Per cent of total from byproduct ovens	66.0	96.7	94.6	89.7	88.3
Producers' stocks of coke, end of year ..... net tons	(1)1,221,737	2,602,099	1,956,442	1,758,086	1,489,049
Disposal of coke, all coke sold or used:					
Furnace coke ..... net tons	47,774,408	31,498,557	42,483,624	50,454,325	55,491,570
Foundry coke ..... net tons	3,600,719	1,682,200	2,089,962	2,846,459	2,591,576
Other industrial (including producer and water gas) ..... net tons	(2)2,283,888	3,193,068	3,581,676	4,224,597	5,452,457
Domestic coke ..... net tons	2,733,414	7,638,141	8,231,013	6,682,959	6,061,694
For all other purposes ..... net tons	(2)	1,311,559	1,458,435	1,165,526	1,146,385
Ovens:					
Beehive, in existence, end of year	62,349	10,934	15,150	18,669	(3)16,295
Byproduct, in existence, end of year	11,156	12,732	12,734	13,016	13,303
Byproduct under construction, end of year	629	.....	492	181	1,327
Cost of coal charged, byproduct ovens, average per ton	$4.76	$3.75	$3.68	$3.92	$4.38
Prices of coke:					
Average spot price of Connellsville furnace coke, f.o.b. ovens	$5.33	$4.09	$4.42	$5.92	$6.01
Average realization on byproduct coke sold:					
Furnace coke (merchant sales)	$6.74	$4.38	$4.55	$5.70	$6.58
Foundry coke	$10.54	$8.15	$8.67	$9.76	$10.15
Other industrial (including water gas)	$9.06	$5.64	$5.86	$6.68	$7.30
Domestic coke	$9.05	$5.90	$6.03	$6.96	$7.88
Yield of byproducts per ton of coal charged:					
Tar ..... gallons	8.1	9.06	8.79	8.52	8.41
Ammonium sulphate or equivalent ..... pounds	21.2	22.33	22.00	21.34	20.85
Surplus gas sold or used ..... M cubic feet	5.9	7.08	6.84	6.71	6.65
Average gross receipts for byproducts, per ton of coke produced:					
Tar sold and used	$0.51	$0.622	$0.571	$0.566	$0.642
Ammonia and its compounds	$0.84	$0.341	$0.364	$0.371	$0.348
Surplus gas sold or used	$1.37	$1.676	$1.507	$1.454	$1.426

(1) Furnace and foundry coke only. (2) "For all other purposes" included under "Other industrial (including producer and water gas)." (3) Number of ovens in existence at plants that operated in 1942 as reported by operators.

Number and capacity of ovens — At the end of 1942 there were 13,303 byproduct ovens of all types in the United States. This represented an addition of 287 to the 13,016 reported at the end of 1941. At the close of the year, 1,327 new ovens with an annual coke capacity of 6,775,000 tons were reported under construction. The total number of beehive ovens in existence, as reported by operators, dropped from 18,669 in 1941 to 16,295 in 1942. This change is not significant, however, as operators may consider certain ovens serviceable one year and not serviceable the next, according to general conditions. Some operators do not report any ovens in existence at plants operated by them that are not leased by them from the owners, and as plants change management from time to time, different reports are received as to the total ovens in existence at the various plants at various times.

Coal charged into coke ovens — In 1942, 100,849,633 tons of coal were charged into coke ovens; of this total, 87,973,821 tons were used in byproduct ovens and 12,875,812 tons in beehive ovens. The total cost of coal charged into byproduct ovens was $385,007,197 ($4.38 per ton), and the cost of coal for beehive ovens was $32,458,011 ($2.52 per ton). The cost of coal (1.41 tons) required to make one ton of byproduct coke was $6.18 in 1942 compared with $5.53 in 1941. Similarly, the cost of coal (1.56 tons) required to make one ton of beehive coke rose from $3.66 in 1941 to $3.93 in 1942. Coals available for coke manufacture that contain an undue proportion of ash or sulphur are usually cleaned before being charged into ovens. Both pneumatic cleaning and wet-washing methods are employed. Some coal is cleaned or washed at the mines, and some byproduct coke plants have washeries adjacent to the ovens. In 1942, 24 byproduct coke plants used coal that had been washed at the mines, and 7 charged into their ovens coal that was cleaned at the ovens. Of the 87,973,821 tons of coal charged into byproduct ovens in 1942, 23,452,747 tons were washed. At beehive ovens 1,824,619 tons or 14 per cent of the 12,875,812 tons of coal carbonized in 1942 were washed.

The leading states mining coking coal, in relative order of importance were Pennsylvania, West Virginia, Kentucky and Alabama. Of the 90,401,393 tons of coal purchased for use at byproduct plants, Pennsylvania supplied 35,636,227 tons, followed in order by West Virginia with 32,407,634 tons, Kentucky with 10,541,692 tons, and Alabama with 7,980,529 tons.

Coke produced and sold or used by producers — The total quantity of byproduct and beehive coke reported as "used by producers in blast furnaces" and "sold for use in blast furnaces" totaled 55,491,570 tons in 1942

Coke produced, Value, Number of Ovens, Coal Charged, and Average Yield in 1942, by States (Exclusive of screenings or breeze)

State	Byproduct						
	Plants in existence	Ovens in existence	Coal used (net tons)	Average cost of coal	Yield of coke from coal (per cent)	Coke produced (net tons)	Value of coke at ovens, per ton
Alabama	8	1,352	7,780,673	$3.13	71.71	5,579,511	$4.72
Colorado	1	188	1,020,797	①	66.24	676,209	①
Illinois	9	915	5,224,824	5.28	70.63	3,690,155	7.42
Indiana	5	1,592	10,147,475	5.50	72.31	7,337,512	7.20
Maryland	1	422	2,904,798	①	72.42	2,103,664	①
Massachusetts	2	215	1,668,918	①	70.49	1,176,359	①
Michigan	7	641	4,359,802	4.87	72.00	3,139,137	6.94
Minnesota	3	196	1,270,855	5.64	75.17	955,301	7.86
New Jersey	2	228	1,439,043	①	72.16	1,038,461	①
New York	8	1,054	7,255,819	5.37	71.40	5,180,384	7.27
Ohio	15	1,963	13,733,261	4.41	72.18	9,912,783	5.96
Pennsylvania	14	3,417	23,889,180	3.44	68.27	16,310,167	4.74
Tennessee	1	44	329,867	①	71.10	234,529	①
Utah	1	56	405,128	①	59.87	242,531	①
Virginia	.....	.....	.....	.....	.....	.....	.....
Washington	.....	.....	.....	.....	.....	.....	.....
West Virginia	5	506	3,502,958	2.92	69.78	2,444,368	3.72
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	6	514	3,040,423	5.19	74.79	2,273,838	7.89
Undistributed	.....	.....	.....	5.29	.....	.....	7.50
Grand total — 1942	88	13,303	87,973,821	$4.38	70.81	62,294,909	$6.07
Grand total — 1941	87	13,016	82,608,837	3.92	70.79	58,482,422	5.41

State	Beehive					
	Ovens in existence	Coal used (net tons)	Average cost of coal	Yield of coke from coal (per cent)	Coke produced (net tons)	Value of coke at ovens, per ton
Alabama	394	155,290	$2.59	61.45	95,428	$6.20
Colorado	260	136,905	3.90	63.87	87,447	①
Illinois	.....	.....	.....	.....	.....	.....
Indiana	.....	.....	.....	.....	.....	.....
Maryland	.....	.....	.....	.....	.....	.....
Massachusetts	.....	.....	.....	.....	.....	.....
Michigan	.....	.....	.....	.....	.....	.....
Minnesota	.....	.....	.....	.....	.....	.....
New Jersey	.....	.....	.....	.....	.....	.....
New York	.....	.....	.....	.....	.....	.....
Ohio	.....	.....	.....	.....	.....	.....
Pennsylvania	13,037	11,292,336	2.51	64.73	7,309,337	5.65
Tennessee	240	122,940	2.96	59.01	72,541	①
Utah	297	43,865	3.90	51.07	22,402	①
Virginia	753	584,620	2.46	59.96	350,521	6.51
Washington	160	.....	.....	.....	.....	.....
West Virginia	1,140	537,959	2.18	62.31	335,221	6.16
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	14	1,897	2.96	60.00	1,138	5.47
Undistributed	.....	.....	.....	.....	.....	7.64
Grand total — 1942	16,295	12,875,812	$2.52	64.26	8,274,035	$5.75
Grand total — 1941	18,669	10,529,316	.....	63.67	6,704,156	5.44

① Included under "Undistributed."

compared with 50,454,325 tons in 1941. The total sales of byproduct and beehive-foundry coke were 2,591,576 tons compared with 2,846,459 tons in 1941. The use of both byproduct and beehive coke as a domestic fuel dropped 621,265 tons in 1942 compared with 1941, principally because a number of merchant byproduct coke plants which had not sold blast furnace coke in recent prior years directed some of their 1942 output to the iron and steel industry.

Stocks of coke and coking coal — According to reports

Salient Statistics of the Coke Industry, 1942

	Byproduct	Beehive	Total
Coke produced, net tons — At merchant plants	15,134,866	.....	15,134,866
At furnace plants	47,160,043	.....	47,160,043
Total	62,294,909	8,274,035	70,568,944
Screenings or breeze produced, net tons	4,600,030	151,653	4,751,683
Coal charged into ovens, net tons	87,973,821	12,875,812	100,849,633
Average value of coal per ton	$4.38	$2.52	$4.14
Average yield, per cent of coal charged — Coke	70.81	64.26	69.97
Breeze	5.30	2.46	5.11
Ovens in existence December 31, 1942	13,303	16,295	29,598
Annual capacity	64,554,972	10,408,595	74,963,567
Ovens under construction December 31, 1942	1,327	.....	1,327
Coke used by producer — In blast furnaces	41,602,950	701,830	42,304,780
For producer gas	810,492	.....	810,492
For water gas	1,527,191	.....	1,527,191
For other purposes	414,009	2,305	416,314
Coke sold to affiliated corporations — For blast furnaces	3,515,351	1,542,503	5,057,854
For other purposes	729,619	452	730,071
Coke sold to other consumers — For blast furnaces	3,242,612	4,886,324	8,128,936
For foundry use	2,250,564	341,012	2,591,576
For water gas	657,761	115,265	773,026
Other industrial use	1,746,562	595,186	2,341,748
For domestic use	5,963,474	98,220	6,061,694
Screenings or breeze used by producer — For steam	3,123,066	30,029	3,153,095
For gas making	46,769	.....	46,769
For other purposes	509,921	5,741	515,662
Screenings or breeze sold	932,122	62,237	994,359
Average receipts per ton sold — Furnace coke (merchant sales)	$6.58	$5.88	$6.16
Foundry coke	$10.15	$7.05	$9.75
For making water gas	$7.80	$6.00	$7.53
Other industrial coke	$7.12	$6.20	$6.88
Domestic coke	$7.88	$5.54	$7.84
Screenings or breeze	$2.74	$0.94	$2.63
Byproducts produced:			
Gas, M cu ft	944,879,637	.....	944,879,637
Burned in coke process, per cent	36.45	.....	36.45
Surplus sold or used	61.96	.....	61.96
Wasted	1.59	.....	1.59
Tar, gal	740,175,619	.....	740,175,619
Ammonium sulphate or equivalent, lb	1,805,025,721	.....	1,805,025,721
Yields of byproducts per ton of coal — Gas, M cu ft	10.74	.....	10.74
Tar, gal	8.41	.....	8.41
Ammonium sulphate or equivalent, lb	20.85	.....	20.85
Coal used per ton of coke, tons	1.41	1.56	1.43
Value of coke at ovens	$378,011,967	$47,601,777	$425,613,744
Value of screenings or breeze	$10,897,121	$151,210	$11,048,331
Value of surplus gas	$88,823,807	.....	$88,823,807
Value of tar sold	$24,155,601	.....	$24,155,601
Value of tar used by producer	$15,813,882	.....	$15,813,882
Value of ammonium sulphate or equivalent	$21,698,572	.....	$21,698,572
Value of other byproducts (crude light oil, etc.)	$42,254,485	.....	$42,254,485
Total value	$581,655,435	$47,752,987	$629,408,422

from byproduct coke plants, stocks of furnace and foundry coke totaled 792,072 tons, domestic coke 661,401 tons, and coke breeze 655,175 tons. Stocks of metallurgical coke increased 10 per cent during the year, but stocks of domestic coke decreased 33 per cent. In the operations of beehive ovens, the output is governed by sales, and ordinarily stocks are negligible. Producers' stocks of beehive coke totaled 35,576 tons on January 1, 1943. Of this amount, 24,617 tons was blast furnace coke, 2,203 tons foundry coke, and 8,756 tons domestic coke.

Generally stocks of bituminous coal held by byproduct operators closely follow the trend of monthly production. On January 1, 1942, stocks of coking coal at byproduct plants totaled 8,901,462 tons, a 37.7 days' supply at the December 1941 rate, and they steadily increased until, by December 31, 1942 stocks on hand amounted to 10,721,414 tons, enough for 43.8 days' requirements at the rate of consumption prevailing in December 1942.

Gross value and yield of byproducts — The gross value of all byproducts sold in 1942 (excluding the value of tar used by the producers and the value of coke breeze produced) increased 11 per cent from $158,809,184 in 1941 to $176,932,465 and amounted to 47 per cent of the gross value of the coke produced. The average yield of the primary coke byproducts per ton of coal carbonized declined in 1942 from that in 1941 because of more rapid coking rates. In 1942 the average yield of gas decreased from 10.81 M cubic feet to 10.74 M cubic feet, tar dropped from 8.52 to 8.41 gallons, and ammonium sulphate or equivalent decreased from 21.34 pounds to 20.85 pounds.

Controller Maintenance

Prepared by Cutler-Hammer, Inc.

▲ MOTOR controllers, being the devices which control the operation of industrial machinery, must be kept in good operating condition at all times to insure low maintenance costs, uninterrupted production schedules and low production costs. Improved maintenance methods have been known to increase the capacity of some factories. It is, therefore, little wonder that the management of an increasing number of companies are giving more attention to maintenance as it relates to production. Particular attention is being given to the establishing of inspection schedules for preventive maintenance.

Regularly scheduled inspections should be made of all electrical equipment — The frequency of inspection depends upon the variable factors of frequency of operation, type of duty and in some cases the type of surrounding atmosphere. Too few inspections result in breakdowns with costly repairs and loss of production time, while too frequent inspections tend to result in the inspections becoming too casual and, of course, again increasing maintenance costs. A trial will soon indicate the best inspection schedule.

The first inspection of a new installation is of paramount importance and should be made at the time of installation. At that time the inspector should familiarize himself with the operation of the drive and the controller and see that he has complete renewal parts information for future reference.

Be sure that an adequate stock of spares is available — It is important that an adequate stock of spares is available for any repair work necessary. The items to be carried in stock vary considerably with the importance of the particular piece of equipment. In some cases it is necessary to have complete standby equipment which in turn is backed up by a stock of spares, while in other cases very few repair parts are required.

Spares are divided into two groups. The first group includes items which are known to wear out regularly, such as contact tips. The second group includes such items which may possibly fail but ordinarily would not wear out. Generally this group includes coils, springs and resistor units. This second group is the one which varies the most and the amount of money spent for this group of spares should be considered as insurance against long delayed shut-downs. While there may not be rapid turn-over in this class of maintenance inventory, it should still be considered as a wise insurance investment. A well chosen inventory of this second group of spares will pay for itself.

When ordering renewal parts give clear, complete description of part required including serial number and full name plate reading. Double check serial number to be sure correct number is specified. An incorrect serial number frequently delays shipment of parts.

Equipment should not be abused — While controller maintenance is of primary concern here, it must be noted that controller abuse generally indicates abuse of the motor and machinery as well.

At the first sign of trouble the controller should be inspected. Disregard of trouble signals may well lead to disproportionate maintenance costs. Controllers are designed to work efficiently under specified conditions . . . operation under other conditions must be made at the risk of equipment failure.

Be sure the application is correct — Probably every electrical maintenance man has at least one piece of equipment that gives him more trouble than dozens of others. It is quite possible that the application of this piece of equipment is incorrect. It may be the result of mounting the controller at a point where there is excess vibration; or the fact that a manually operated controller is used when an automatic controller, which is designed for more frequent operation and more severe service, should be used. It may be the result of a resistor used to regulate the speed of the motor not having the correct characteristics for the load application or it may be the controller is continually overloaded. Often it is a case of an improper type of enclosure for the particular installation. In any case the conditions should be remedied if efficient production is to be maintained.

When on-the-spot analysis fails to uncover the trouble, it is suggested that the factory be consulted. All details having a bearing on the trouble should be included in the letter.

GENERAL CONTACT TROUBLE

Excessive Heating

Overload — This condition can be quickly determined by placing an ammeter in the circuit. It must be corrected if serious damage to the motor and machine is to be prevented.

Low contact pressure — It is necessary to replace springs which may have lost compression due to overheating or flashing.

Loose connection — Be sure all contact screws and terminal connections are tight.

Insulating coating on contact surface — Dust, grease or oxides will insulate copper contact surfaces. Dust and grease can be eliminated by using a dust tight enclosure. Where a dust tight enclosure is not used, keep contacts clean. Ordinary operation cleans any copper oxide which forms on the face of the contact. If operated less than once every eight hours the formation of oxide may cause troublesome overheating. Where such trouble occurs replace copper contacts with silver faced contacts. Excessive vibration also causes copper oxide to form on the surface of the contact. The vibration should be eliminated or the controller should be moved to a spot free from vibration.

Excessive Arcing and Wear on Sliding Contacts

Rapid lever operation — At times operators manipulate manual controllers so rapidly that the motor is practically started across-the-line. This speed of operation will result in excessive burning and arcing of contacts in addition to probable damage to the motor and machine. Abusive operation will cause flashing over which may lead to a major repair job.

Irregular surfaces — Irregular surfaces on sliding contacts cause rapid wear and excessive heat. It is recommended that sandpaper be used to keep the contacts in condition since other abrasives may cling to the contacts. Emery cloth should never be used in this operation. The contacts should be kept smooth but care should be taken not to remove any more metal than is necessary during the sanding operation. Never file contacts except where there is a sharp projection extending beyond the contact surface. Such projections should be filed down to the surface only.

Poor lubrication — Sliding contacts must be kept clean and lubricated with a very light coat of vaseline.

GENERAL RESISTOR TROUBLE

Armature or secondary resistor burnouts — Burnouts of this type can be traced to improper application, overloading, improper operation of manually operated controllers or using a starting resistor for speed regulation by holding the lever on a button for a length of time.

Overloads can be quickly determined by placing an ammeter in the line and checking against the name plate data.

Manual controllers should be operated properly. Holding the controller on an intermediate point when the resistor is not designed for continuous duty is the most common cause of burnouts. When such practice is called to the operator's attention, the trouble generally disappears.

Field resistor burnouts — Failures of this nature can be attributed to improper field resistor, unusual voltage condition or electrolysis where high resistance, low wattage rheostats are used.

Checking the name plate of the motor for full field current of the rheostat is the first step in running down this type of trouble. Next determine if the equipment has been subjected to any unusual voltage surges or if the rheostat has been placed directly across-the-line.

Most rheostats and resistors develop enough heat to keep the moisture content down. However, moisture occasionally gets into a low voltage resistor resulting in electrolysis and an open circuit. If there is any danger of moisture damage, a moisture protected resistor should be used.

Failure due to corrosive atmosphere — When such failures occur it is recommended that the manufacturer be given full particulars as to the kind of gases encountered. A special resistor can be designed to withstand unusual atmospheric conditions.

Breakage or mechanical failure — A resistor that has failed mechanically — creating an open circuit — can be temporarily repaired by shorting out the broken element providing it is only a very small portion of the complete resistor. It is important that permanent repairs be made at the earlest possible moment.

The most frequent cause of mechanical breakage is vibration. The resistor should be moved to a spot free from vibration or replaced by the unbreakable type of resistor.

Failure to Obtain Correct Speed

Satisfactory changes in speed through the use of a resistor are obtained only when the resistor is designed for the characteristics of the motor and for the type of load on the motor. A check of the nameplate on the motor and controller should indicate if the proper operation will be obtained. Resistors that are not designed for the motor and its load should not be used.

Speed reduction — Speed reduction can be obtained by using a resistor in series with the armature of a d-c motor, and by using a resistor in the secondary circuit of a slip ring motor.

If the d-c motor has a rheostat in its field circuit the speed should be reduced by using the armature resistor only when the rheostat is in the full field position. The armature resistor is usually designed for the motor loading from this point down to the load at the slow speed position.

When a rheostat is not used the armature resistor is designed for the motor loading at full speed down to the slow speed position.

Speed increase — A speed increase above the normal speed of a d-c motor is obtained by inserting a resistance in series with the shunt field. The ohmic value of the resistance and the maximum and minimum field currents must be known to properly design a field rheostat.

MANUALLY OPERATED CONTROLLERS

Excessive Burning of Contacts

Faulty spring tension — Contact pressure of manual controllers should be such that there is no arcing of contacts. This can readily be determined by inspection. Also, in the case of drum controllers the star wheel lever spring should be adjusted to enough tension to serve as a feeler in centering the contact, otherwise there is always the possibility of the edge of the segment making contact causing excessive burning.

Improper operation — Since manual controllers depend on the operator for timing in accelerating the motor, improper operation is always possible. No resistance type starter designed for starting duty should be operated so fast that the motor is practically thrown across-the-line; nor should such starters be stopped at a mid-point. If manual controllers for a-c multi-speed motors are operated fast without a decided pause at each intermediate speed unusually high voltages can be built up causing the controller to "flash over" damaging the motor and the machine it is driving.

Failure of Low Voltage Release to Hold In

Low voltage — Coil failure — With face plate controllers failure can be caused by either low voltage or coil failure. Also exceptionally low field current in d-c starter installations using the low voltage release coil in series with the motor shunt field can be troublesome. In such cases the motor field current should be checked and the correct low voltage release coil installed.

Voltage dips — Occasionally the low voltage release of a manual compensator drops out due to voltage dips. This condition can be corrected by adding a time delay low voltage release assembly to the compensator.

Dirty magnet face — Rust or dirt on the magnet face may prevent the low voltage release from holding in. The magnet face must be kept clean.

Excessive Mechanical Wear

Abrasive dust — This is a common cause of failure and can best be corrected by using the proper enclosure. An alternative is frequent inspection and cleaning plus application of a very light coat of vaseline to sliding surfaces.

Frequent operation — Constant operation and generally hard service tends to wear out a face plate manual controller in a short time as it is not designed for frequent operation. If constant operation is required, a drum type manual controller or a magnetic controller should be substituted.

MAGNETICALLY OPERATED CONTROLLERS

Coil failure — Providing the proper voltage is maintained, coil failure occurring after several years is the result of moisture getting into the coil.

Spare coils should be stored in a clean, dry location. Should the coils become wet, they should be baked in an oven at a temperature from 110 to 125 C. If coils are painted with an insulating varnish as additional protection against moisture, care should be taken that the varnish used is not the type which will attack the insulation.

In cases where leads are assembled to the coil or part of the coil, the coil must not be carried by the lead.

A-c coils must operate successfully on voltage between 85 and 110 per cent of normal, d-c coils between 80 and 110 per cent of normal to meet the N. E. M. A. standards. Whenever the voltage range exceeds these values, it is recommended that the condition be outlined to the manufacturer so that special coils can be provided. Overvoltage will cause excessive coil heating.

Low frequency — If a coil is used on a lower frequency than the one for which it was intended, failure of the a-c coil is probable.

Failure of the magnetic circuit to close — This type of a-c coil failure may be due to mechanical sticking, binding or to low voltage. An a-c coil can burn out on low voltage, for the current at low voltage of an open magnet, though not sufficient to close the magnet, may be many times higher than the current at standard voltage when the magnet is closed.

Failure to insert protection resistor — Neglecting to insert protecting resistor in series with d-c coils when required will cause the coils to burn out. Whenever resistors are cut in after the device starts to operate, any overheating should be checked carefully to be sure the protecting resistor is inserted in the circuit.

Contactor and relay adjustment — Care should be taken to see that correct acceleration and deceleration adjustments are made to contactors and relays based on the application for which they were designed.

Care of electrical interlocks — Electrical interlocks must be kept clean, adjusted and in alignment to assure proper contact.

Noisy or Chattering Magnets on A-c Controllers

Low voltage — In addition to causing a noisy magnet, low voltage will burn out the coil should the magnet fail to close. A voltmeter will quickly reveal a low voltage condition.

Broken shading coil — The magnet will chatter if the shading coil is broken. Frequently the shading coil need only be replaced but often the break is the result of the magnet face being worn down to the point where the magnet frame must be replaced.

Dirt and grease — Dust and grease often collect on the magnet faces causing it to be noisy. To insure quiet and free operation, it is necessary to keep the faces clean. Bearing points should be lubricated with a good grade of light machine oil. Excess oil should be removed to prevent dust and dirt from collecting.

Misalignment — Misalignment of magnet parts may cause the magnet to be noisy. Misalignment frequently follows an accidental blow to the magnet and can be corrected by lining it up again and straightening bent parts. Be sure magnet frame and armature member are sealing properly. Occasionally it is necessary to file down a high point on the magnet face with a fine file.

Preventive Maintenance

KEEPS STEEL MILL *Motors* RUNNING

. . . . based on the adage of "an ounce of prevention," this article suggests schedules of maintenance inspections . . . . trouble shooting charts are also included . . . .

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▲ STEEL plant management purchases electrical equipment to drive machines throughout the plant. They provide motors that are adequate to do the particular job. After the equipment is installed, management expects return from the investment in the machines. If the maintenance department does not plan and carry an adequate program that has for its purpose, the prolonging of the life of the equipment and obtaining the maximum output, the investment shows a decided loss.

The ideal motor maintenance program aims at prevention of breakdowns rather than their repair. Maintenance involves competent, periodic and systematic inspection. A thorough survey of each motor installation should be made and a systematic inspection and maintenance schedule established and enforced.

Records must be kept consistently on the schedule selected. Several excellent record systems have been developed and reduced to printed form, so that it is not necessary to go to the trouble and expense of devising individual systems.

Prevention of breakdowns may be helped by a thorough analysis of the equipment involved. For example, if the difficulty is the frequent tripping of overload relays, it may be the installation of a different type of relay with thermoguards on the motor will enable the motor to carry the loads without an injurious temperature rise.

CHART I — General Good Maintenance Practices

Keep motor off line when not needed.	Saves unnecessary wear of brushes, commutator and bearings, saves lubrication.
Do not leave field circuit excited unless motor has been especially designed for this type duty.	Check temperature of shunt fields with thermometer to see that temperature does not exceed 90 C. When field must be excited, caution maintenance men to be sure field circuit is opened before working on the motor.
Keep motor clear of metal dust or cuttings that can be drawn into windings and pole pieces.	Magnetic attraction will draw metal parts into the air gap and damage windings.
Reassembling of motor.	Be sure to retain proper air gaps in motor by checking bore of pole faces before dismantling. Reassemble, replacing poles and liners in original position.
Note wearing parts and parts frequently replaced to determine anticipated repairs.	Carry in proper store room stock of replacement parts. Make survey of standard repair parts to avoid duplication of parts to be carried.

MAINTENANCE SCHEDULES SHOULD INCLUDE SYSTEMATIC INSPECTION

It is impossible to give any hard and fast rules for frequency of inspection. The following suggestions are based on average conditions found in steel mills.

Once a week check oil level in the bearings and see that the oil rings are moving freely. Check the temperature of the motor bearings and primary iron with the hand. Sniff the warm air coming from open motors. The fumes emanating from overheated insulation are unmistakable.

Once a month check the brush holders, brushes and shunts. Blow out the motor with compressed air.

CHART II — A-c, D-c Motor Maintenance Check Chart

Trouble	Cause	What to do
Hot Bearings	Bent or sprung shaft.	Straighten or replace shaft.
	Excessive belt pull.	Decrease belt tension.
	Pulley too far away.	Move pulley closer to bearing.
	Pulley diameter too small.	Use larger pullies.
	Misalignment.	Correct by realignment of drive.
Sleeve	Oil grooving in bearing obstructed by dirt.	Remove bracket or pedestal with bearing and clean oil grooves and bearing housing; and new oil.
	Bent or damaged oil rings.	Repair or replace oil rings.
	Oil too heavy.	Use a recommended lighter oil.
	Oil too light.	Use a recommended heavier oil.
	Insufficient oil.	Fill reservoir to proper level in overflow plug with motor at rest.
	Too much end thrust.	Reduce thrust induced by driven machine or supply external means to carry thrust.
	Badly worn bearing.	Replace bearing.
Ball	Insufficient grease.	Maintain proper quantity of grease in bearing.
	Deterioration of grease or lubricant contaminated.	Remove old grease, wash bearings thoroughly in kerosene and replace with new grease.
	Excess lubricant.	Reduce quantity of grease. Bearing should not be more than ½ filled.
	Heat from hot motor or external source.	Protect bearing by reducing motor temperature.
	Overloaded bearing.	Check alignment, side thrust and end thrust.
	Broken ball or rough races.	Replace bearing; first clean housing thoroughly.
Oil leakage from overflow plugs	Stem of overflow plug not tight.	Remove, re-cement threads, replace and tighten.
	Cracked or broken overflow plug.	Replace the plug.
	Plug cover not tight.	Requires cork gasket, or if screw type, may be tightened.
Motor dirty	Ventilation blocked, end windings filled with fine dust or lint.	Clean motor will run 10 to 30 C cooler. Dust may be cement, sawdust, rock dust, grain dust, coal dust and the like. Dismantle entire motor and clean all windings and parts.
	Rotor winding clogged.	Clean, grind and undercut commutator. Clean and treat windings with good insulating varnish.
	Bearing and brackets coated inside.	Dust and wash with cleaning solvent.
Motor wet	Subject to dripping.	Wipe motor and dry by circulating heated air through motor. Install drip or canopy type covers over motor for protection.
	Drenched condition.	Motor should be covered to retain heat and the rotor position shifted frequently.
	Submerged in flood waters.	Dismantle and clean parts. Bake windings in oven at 105 C for 24 hours or until resistance to ground is sufficient. First make sure commutator bushing is drained of water.

CHART III — Trouble Correction Chart for A-c Motors

Trouble	Cause	What to do
Motor stalls	Wrong application.	Change type or size. Consult manufacturer.
	Overloaded motor.	Reduce load.
	Low motor voltage.	See that nameplate voltage is maintained.
	Open circuit.	Fuses blown, check overload relay, starter and push-button.
	Incorrect control resistance of wound rotor.	Check control sequence. Replace broken resistors. Repair open circuits.
Motor connected but does not start	One phase open. Motor may be overloaded.	See that no phase is open. Reduce load.
	Rotor defective.	Look for broken bars or rings.
	Poor stator coil connection.	Remove end bells, locate with test lamp.
Motor runs and then dies down	Power failure.	Check for loose connections to line, to fuses and to control.
Motor does not come up to speed	Not applied properly.	Consult supplier for proper type.
	Voltage too low at motor terminals because of line drop.	Use higher voltage on transformer terminals or reduce load.
	If wound rotor, improper control operation of secondary resistance.	Correct secondary control.
	Starting load too high.	Check load motor is supposed to carry at start.
	Low pull-in torque of synchronous motor.	Change rotor starting resistance or change rotor design.
	Check that all brushes are riding on rings.	Check secondary connections. Leave no leads poorly connected.
	Broken rotor bars.	Look for cracks near the rings. A new rotor may be required as repairs are usually temporary.
	Open primary circuit.	Locate fault with testing device and repair.
Motor takes too long to accelerate	Excess loading.	Reduce load.
	Poor circuit.	Check for high resistance.
	Defective squirrel-cage rotor.	Replace with new rotor.
	Applied voltage too low.	Get power company to increase voltage tap.
Wrong rotation at start	Wrong sequence of phases.	Reverse connections of motor or at switchboard.
Motor overheats while running under load	Check for overload.	Reduce load.
	Wrong blowers or air shields, may be clogged with dirt and prevent proper ventilation of motor.	Good ventilation is manifest when a continuous stream of air leaves the motor. If not, check manufacturer.
	Motor may have one phase open.	Check to make sure that all leads are well connected.
	Grounded coil.	Locate and repair.
	Unbalanced terminal voltage.	Check for faulty leads, connections and transformers.
	Shorted stator coil.	Repair and then check wattmeter reading.
	Faulty connection.	Indicated by high resistance.
	High voltage.	Check terminals of motor with voltmeter.
	Low voltage.	
	Rotor rubs stator bore.	If not poor machining, replace worn bearings.

Trouble	Cause	What to do
Motor vibrates after corrections have been made.	Motor misaligned.	Realign.
	Weak foundations.	Strengthen base.
	Coupling out of balance.	Balance coupling.
	Driven equipment unbalanced.	Rebalance driven equipment.
	Defective ball bearing.	Replace bearing.
	Bearings not in line.	Line up properly.
	Balancing weights shifted.	Rebalance rotor.
	Wound rotor coils replaced.	Rebalance rotor.
	Polyphase motor running single phase.	Check for open circuit.
	Excessive end play.	Adjust bearing or add washer.
Unbalanced line current on polyphase motors during normal operation	Unequal terminal volts.	Check leads and connections.
	Single phase operation.	Check for open contacts.
	Poor rotor contacts in control wound rotor resistance.	Check control devices.
	Brushes not in proper position in wound rotor.	See that brushes are properly seated and shunts in good condition.
Scraping noise	Fan rubbing air shield.	Remove interference.
	Fan striking insulation.	Clear fan.
	Loose on bedplate.	Tighten holding bolts.
Magnetic noise	Air gap not uniform.	Check and correct bracket fits or bearing.
	Loose bearings.	Correct or renew.
	Rotor unbalance.	Rebalance.

Once a year check air gap with feeler gauge. Check insulation resistance with megger. Check line voltage with voltmeter, and load with ammeter. Clean out and replace grease in ball and roller bearings. Check renewal parts stock in light of the past years' experience.

Every two years dismantle the motor. See that all windings are tight. Replace loose wedges and loose bands before dipping in varnish and baking. Inspect commutators and commutator connections. Sleeve bearings require no flushing. At intervals of about two years in average service, or during general overhaul periods, remove the bracket and wash out the bearing housing. Use hot kerosene oil and compressed air if available.

FAULTY BEARINGS CAUSE MOST MOTOR FAILURES

All motors depend upon a mechanical assembly of some sort for the transformation of electrical energy into mechanical energy or work. The bearings are a very important link in this mechanical assembly.

Bearings probably cause more shutdowns, delay and expense, than any other cause. This is not surprising, when it is remembered that they are victims of poor foundations, misalignment, vibration, thrust from couplings, dirt under and over lubrication, and frequently the wrong lubricant. All this in addition to their real job of supporting a rapidly revolving part.

The first requirement of successful bearing operation is lubrication. This entails more than just an adequate supply of lubricant; the lubricant, the bearing design, and its condition, must be correct. Safe operating temperature for bearings under normal operating conditions is considered to be 40 C rise above the surrounding room air. At this temperature a bearing feels only comfortably warm to the hand. Assuming proper mechanical condition of the bearing, whether sleeve or ball, and bearing assembly, and assuming that proper lubricants are used, temperatures elevated above 40 C rise call for immediate investigation.

Ball bearings have become increasingly important with the use of totally inclosed and fan-cooled motors. In a ball bearing, a series of steel balls act as the separating medium, both when the motor is stationary and when it is running.

To keep the steel balls uniformly distributed around the bearing a cage or retainer is used, each ball having its own pocket. The balls have rolling contact with the raceway, but sliding contact with the surfaces of the retainer. This means that lubrication is necessary.

Most ball bearings used in horizontal motors are grease lubricated although some supplied with vertical motors use oil. Follow the advice of the motor manufacturer in selecting a suitable grease. Carelessness in allowing containers to remain open often causes trouble from abrasive dirt. Soda-base soap greases are usually preferred on account of their high melting point and their stability. They mix readily with water, however, and tend to form an emulsion.

Ball bearings in distress can usually be detected by

CHART IV — Trouble Correction Chart for D-c Motors

Trouble	Cause	What to do
Fails to start	Circuit not complete.	Switch open, leads broken.
	Brushes not down on commutator.	Held up by brush springs, need replacement. Brushes worn out.
	Brushes stuck in holders.	Remove and sand, clean up brush boxes.
	Armature locked by frozen bearings in motor or main drive.	Remove brackets and replace bearings or recondition old bearings if inspection makes possible.
	Power may be off.	Check line connections to starter with light. Check contacts in starter.
Motor starts then stops and reverses direction of rotation	Reverse polarity of generator that supplies power.	Check generating unit for cause of changing polarity.
	Shunt and Series fields are bucking each other.	Reconnect either the shunt or series field so as to correct the polarity. Then connect armature leads for desired direction of rotation. The fields can be tried separately to determine the direction of rotation individually and connected so both give same rotation.
Motor does not come up to rated speed	Overload.	Check bearing to see if in first class condition with correct lubrication. Check driven load for excessive load or friction.
	Starting resistance not all out.	Check starting to see if mechanically and electrically in correct condition.
	Voltage low.	Measure voltage with meter and check with motor name plate.
	Short circuit in armature windings or between bars.	For shorted armature inspect commutator for blackened bars and burned adjacent bars. Inspect windings for burned coils or wedges.
	Starting heavy load with very weak field.	Check full field relay and possibilities of full field setting of the field rheostat.
	Motor off neutral.	Check for factory setting of brush rigging or test motor for true neutral setting.
	Motor cold.	Increase load on motor so as to increase its temperature, or add field rheostat to set speed.
Motor runs too fast	Voltage above rated.	Correct voltage or get recommended change in air gap from manufacturer.
	Load too light.	Increase load or install fixed resistance in armature circuit.
	Shunt field coil shorted.	Install new coil.
	Shunt field coil reversed.	Reconnect coil leads in reverse.
	Series coil reversed.	Reconnect coil leads in reverse.
	Series field coil shorted.	Install new or repaired coil.
	Neutral setting shifted off neutral.	Reset neutral by checking factory setting mark or testing for neutral.
	Part of shunt field rheostat or unnecessary resistance in field circuit.	Measure voltage across field and check with name plate rating.
	Motor ventilation restricted causing hot shunt field.	Hot field is high in resistance check causes for hot field, in order restore normal shunt field current.
Motor gaining speed steadily and increasing load does not slow it down	Unstable speed load regulation.	Inspect motor to see if off neutral. Check series field to determine shorted turns. If series field has a shunt around the series circuit that can be removed.
	Reversed field coil shunt or series.	Test with compass and reconnect coil.
	Too strong a commutating pole or commutating pole air gap too small.	Check with factory for recommended change in coils or air gap.
Motor runs too slow continuously	Voltage below rated.	Measure voltage and try to correct to value on motor name plate.
	Overload.	Check bearings of motors and the drive to see if in first class condition. Check for excessive friction in drive.
	Motor operates cold.	Motor may run 20 per cent slow due to light load. Install smaller motor, increase load or install partial covers to increase heating.

Trouble	Cause	What to do
Motor runs too slow continuously—*continued*	Neutral setting shifted.	Check for factory setting of brush rigging or test for true neutral setting.
	Armature has shorted coils or commutator bars.	Remove armature to repair shop and put in first class condition.
Motor overheats or runs hot	Over loaded and draws 25 per cent to 50 per cent more current than rated.	Reduce load by reducing speed or gearing in the drive or loading in the drive.
	Voltage above rated.	Motor runs drive above rated speed requiring excessive horsepower reduce voltage to name plate rating.
	Inadequately ventilated.	Location of motor should be changed, or restricted surroundings removed. Covers used for protection are too restricting of ventilating air and should be modified or removed. Open motors cannot be totally enclosed for continuous operation.
	Draws excessive current due to shorted coil. Grounds in armature such as two grounds which constitute a short.	Repair armature coils or install new coil. Locate grounds and repair or rewind with new set of coils.
	Armature rubs pole faces due to off center rotor causing friction and excessive current.	Check brackets or pedestals to center rotor and determine condition of bearing wear for bearing replacement.
(a) Hot armature	Core hot in one spot indicating shorted punchings and high iron loss.	Sometimes full slot metal wedges have been used for balancing. These should be removed and other means of balancing be investigated.
	Punchings uninsulated. Punchings have been turned or band grooves machined in the core. Machined slots.	No load running of motor will indicate hot core and drawing high. No load armature current. Replace core and rewind armature. If necessary to add band grooves grind into core. Check temperature on core with thermometer not to exceed 90 C.
(b) Hot commutator	Brush tension too high overload.	Limit pressure to 2 to 2½ lb psi. Check brush density and limit to density recommended by the brush manufacturer.
	Brushes off neutral.	Reset neutral.
	Brush grade too abrasive.	Get recommendation from manufacturer.
	Shorted bars.	Investigate commutator mica and undercutting and repair.
	Hot core and coils that transmit heat to commutator.	Check temperature of commutator with thermometer to see that total temperature does not exceed ambient plus 55 C rise, total not to exceed 105 C.
	Inadequate ventilation.	Check as for hot motor.
(c) Hot fields	Voltage too high.	Check with meter and thermometer and correct voltage to name plate value.
	Shorted turns or grounded turns.	Repair or replace with new coil.
	Resistance of each coil not the same.	Check each individual coil for equal resistance to be 10 per cent and if one coil is too low replace coil.
	Inadequate ventilation.	Check as for hot motor.
	Coil not large enough to radiate its loss wattage.	New coils should replace all coils if room is available in motor.
	Overheating deteriorates insulation and shortens life of the motor.	
Motor vibrates and indicates unbalance	Armature out of balance.	Remove and statically balance or balance in dynamic balancing machine.
	Misalignment.	Realign.
	Loose or eccentric pulley.	Tighten pulley on shaft or correct eccentric pulley.
	Belt or chain whip.	Adjust belt tension.
	Mismating of gear and pinion.	Recut, realign, or replace parts.
	Unbalance in coupling.	Rebalance coupling.
	Bent shaft.	Replace or straighten shaft.
	Foundation inadequate.	Stiffen mounting place members.
	Motor loosely mounted.	Tighten holding down bolts.
	Motor feet uneven.	Add shims under foot pads to mount each foot tight.
Motor sparks at brushes or does not commutate	Neutral setting not true neutral.	Check and set on factory setting or test for true neutral.

Trouble	Cause	What to do
Motor sparks at brushes or does not commutate—*continued*	Commutator rough.	Grind and roll edge of each bar.
	Commutator eccentric.	Turn and grind commutator.
	Mica high not undercut.	Undercut mica.
	Commutating pole strength too great causing over compensation or strength too weak indicating under-compensation.	Check with manufacturer for correct change in air gap or new coils for the commutating coils.
	Shorted commutating pole turns.	Repair coils or install new coils.
	Shorted armature coils on commutator bars.	Repair armature by putting into first class condition
	Open circuited coils.	Same as above.
	Poor soldered connected to commutator bars.	Resolder with proper alloy of tin solder.
	High bar or loose bar in commutator at high speeds.	Inspect commutator nut or bolts and retighten and return and grind commutator face.
	Brush grade wrong type. Brush pressure, too light, current density excessive, brushes stuck in holders. Brushes shunt loose.	See Brushes.
	Brushes chatter due to dirty film on commutator.	Resurface commutator face and check for change in brushes.
	Vibration.	Eliminate cause of vibration by checking mounting and balance of rotor.
Brush wear excessive	Brushes too soft.	Blow dust from motor and replace brushes with a changed grade as recommended by manufacturer.
	Commutator rough.	Grind commutator ace.
	Abrasive dust in ventilating air.	Reface brushes and correct condition by protecting motor.
	Off neutral setting.	Recheck factory neutral or test for true neutral.
	Bad commutation.	See corrections for commutation.
	High, low or loose bar.	Retighten commutator motor bolts and resurface commutator.
	Brush tension excessive.	Adjust spring pressure not to exceed 2 psi.
	Electrical wear due to loss of film on commutator face.	Resurface brush faces and commutator face.
	Threading and grooving.	Same as above.
	Oil or grease from atmosphere or bearings.	Correct oil condition and surface brush faces and commutator.
	Weak acid and moisture laden atmosphere.	Protect motor by changing ventilating air, or change to enclosed motor.
Motor noisy	Brush singing.	Check brush angle and commutator coating, resurface commutator.
	Brush chatter.	Resurface commutator and brush face.
	Motor loosely mounted.	Tighten foundation bolts.
	Foundation hollow and acts as sounding board.	Coat underside with sound proofing material.
	Strained frame.	Shim motor feet for equal mounting.
	Armature punchings loose.	Replace core on armature.
	Armature rubs pole faces.	Recenter by replacing bearings or relocating brackets or pedestals.
	Magnetic hum.	Refer to manufacturer.
	Belt slap or pounding.	Check condition of belt and change belt tension.
	Excessive current load.	May not cause over heating but check chart for correction shorted or ground and coils.
	Mechanical vibration.	Check chart for causes of vibration.
	Noisy bearings.	Check alignment, loading of bearings, lubrication and get recommendation of manufacturer.

undue heating or by unusual noise. Broken or nicked balls cause rapid destruction of the bearing. They can be detected by the "clicks."

If the conventional 40 C rise above the surrounding air is exceeded, look for an overfilled bearing, since the first result of over-greasing is heating caused by churning of the grease. The general rule is that the housing should not be over half full. Clean the old grease from the bearing and from the housing once a year and replace it with new grease. Average service is assumed.

After the machine is dismantled, the bearing should be carefully wrapped in clean cloth or paper to protect it from outside dirt. Remove all old grease from the housing and clean the housing and the bearing in Stoddard solvent. Remove final residue of cleaning medium with a light oil before filling with new grease. The container with fresh grease must be carefully protected from dirt.

CHECK AIR GAP WITH FOUR READINGS

The air gap in a motor is dependent first on proper maintenance of the bearings and second on the proper alignment of the brackets or pedestals with the frame. Alternating-current motors operate with less gap than direct-current motors, and are therefore more critical. Check the air gap with a feeler gauge at the established schedule period. Make these checks at the pulley end, taking four readings on each motor, 90 degrees apart. For motors below 10 hp, a minimum gap of .005 in. should be maintained. Above 10 hp the minimum gap should be .010 in.

COUPLINGS REQUIRE PARALLEL ALIGNMENT

Where coupled type motors are used, the couplings require regular inspection. Faulty alignment in a solid coupling is reflected in bearing trouble and vibration. Make sure that all dowel pins are in correct position and check the faces of the couplings with a feeler gauge after the bolts have been removed. Shift the motor position to make the faces of the two half couplings parallel.

Flexible couplings will operate under more severe misalignment without causing trouble; however, the two halves should be checked with a steel scale to make sure they are in alignment. Any misalignment means increased wear on the pins, fingers, and leather discs, whichever may be used. Special type flexible couplings should be checked according to the manufacturer's instructions.

INSULATION MUST BE CLEAN AND DRY

The electrical conductors in a motor are separated from the magnetic circuit and from the mechanical assembly by materials generally grouped under the term "insulation." Insulation is also used in commutators to separate the bars from each other and in coils to isolate individual turns. It is important that the insulation be maintained so as to function as a separator between the copper coils in the motor and the mechanical assembly. Regardless of the class of insulation used, remember that electrical insulation materials are nonconductors only when clean and dry.

The importance of keeping electrical equipment clean and dry is always worth stressing. Accumulations of dust, dirt and oil not only contribute to insulation breakdown, but they operate to increase the motor temperature through restrictions of ventilation. Dust and dirt is effectively removed with compressed air at about 50 pounds pressure. Do not direct compressed air against the insulation until certain that it is free from moisture that may have accumulated in the air line from condensation. Too great an air pressure may loosen the binding tape or injure the insulation by sand blasting with the abrasive dirt which is nearly always present. It may not be possible to remove all dust and dirt by blowing with compressed air. If the accumulation of dirt contains oil or grease, a solvent, such as Stoddard solvent or cleaners' naphtha, will usually be required to remove it.

The petroleum distillates are the solvents having the least corrosive action on insulation varnishes, and for that reason where conditions permit are preferable to the others. The Stoddard type solvent, produced by all the major oil companies, with a minimum flash point of 100 F, minimizes the fire hazard, and should be used in preference to gasoline or benzene. Every precaution should be taken however, to prevent fires or explosions. Before any solvent is used, be sure that there is good ventilation and minimum fire risk. Do not let the workers' clothing become saturated with the solvent. Always have fire extinguishers of the carbon tetrachloride type handy. If a hose is used to spray either cleaning solution or varnish, make sure that the nozzle is grounded.

The time to apply varnish treatment is after the motor has been thoroughly cleaned. Use a baking insulation varnish recommended by the supplier for the particular conditions encountered. Two dips and bakes may be sufficient for normal conditions, while for extreme conditions of moisture and corrosive gases four dips and bakes may be justified. One or two additional coats of red synthetic insulation enamel may be justified under extreme conditions.

Dry the motor in an oven before the dipping in varnish. Electric or steam heat is the safest and most convenient. Make sure that suitable temperature control is provided and that it is effective so as to prevent injury to the insulation. Maximum dry-out temperature is 115 C. Baking temperature for the varnish and length of the baking period will depend on the type of varnish used.

Insulation tests are made to determine the condition of the insulation rather than the quality of the insulation. While special conditions may justify dielectric tests, over potential tests, high frequency tests, or dielectric power factor tests, a test to determine the insulation resistance is generally what is required in maintenance work. Use Class B insulation for motors whose history shows breakdowns resulting from operation at elevated temperatures.

The most convenient way to read insulation resistance is with a megger. The 500-volt type is generally used. A higher-voltage megger may damage low voltage insulation. Remember that the readings are valuable only from a comparative standpoint and that they vary

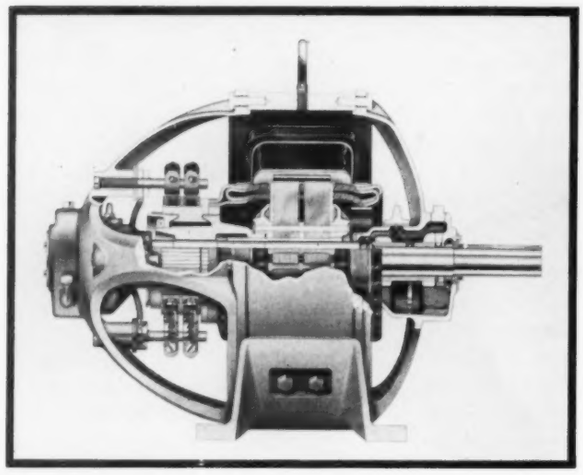


Figure 1 — Cutaway view of direct-current motor. 1 — field coils, 2 — armature, 3 — armature coils, 4 — commutator, 5 — brush rigging, 6 — sleeve bearing, 7 — oil overflow and filler plug.

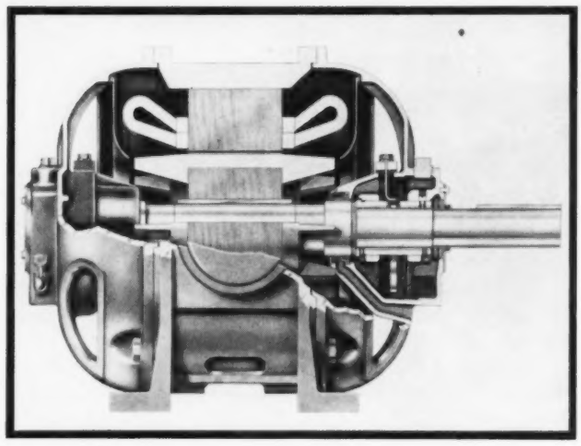


Figure 2 — Cutaway view of a-c squirrel cage motor. 1 — stator coils, 2 — squirrel cage rotor, 3 — sleeve bearings, 4 — oil overflow and filler plug.

greatly with the temperature of the apparatus. A safe general rule is that the insulation resistance should be approximately one megohm for each 1000 volts of operating voltage, with one megohm as a minimum.

CARE REQUIRED FOR D-C MOTOR REPAIR

Direct-current motors add the commutator and its current-collecting details to the general maintenance problem. The armature is the heart of the direct-current motor. Through it flows the main-line current, and if the machine is overloaded the armature is the first to give evidence of distress.

Figure 3 — To assure proper maintenance and prevent sparking, it is necessary to undercut the mica below the surface of the faster-wearing copper commutator bars on a direct-current motor. This tool undercuts the mica to 1/16 in. below the commutator surface.

When dismantling a d-c motor for periodic overhauling the following points should be observed. Do not roll the armature on the floor; a coil may be injured or the steel banding wire may be nicked. Support or lift the armature only by its shaft if possible. Never allow the weight of the armature to rest on the commutator or on the coils. Inspect the coils carefully to see that they are tight and where necessary replace the wedges. Replace any bands that may be loose.

As far as possible duplicate the banding originally furnished by the manufacturer. Do not change the material in the banding wire, the diameter of the banding wire, or the width or position of the band. Increasing the band width may cause heavy currents in the bands sufficient to overheat and melt the solder.

Only experienced workmen should tighten loose commutators. If the commutator bars are tight they will give out a clear bell-like ring when tapped lightly with a small hammer. If the commutator does not ring, but gives out a flat sound when struck, the front V should be tightened.

The exposed portion of the front mica V ring is normally a catchall for oil and dirt. This section should be cleaned and protected with a layer of surgical tape and twine to prevent flashovers and breakdown to ground. Red synthetic enamel will give a smooth finish, resistant to oil and carbon dust.

UNIFORM SPRING TENSION ON BRUSHES

Check the brush rigging carefully. Most brush holders in use today are box type, and the brush holder should be replaced when the inside broached section is worn.

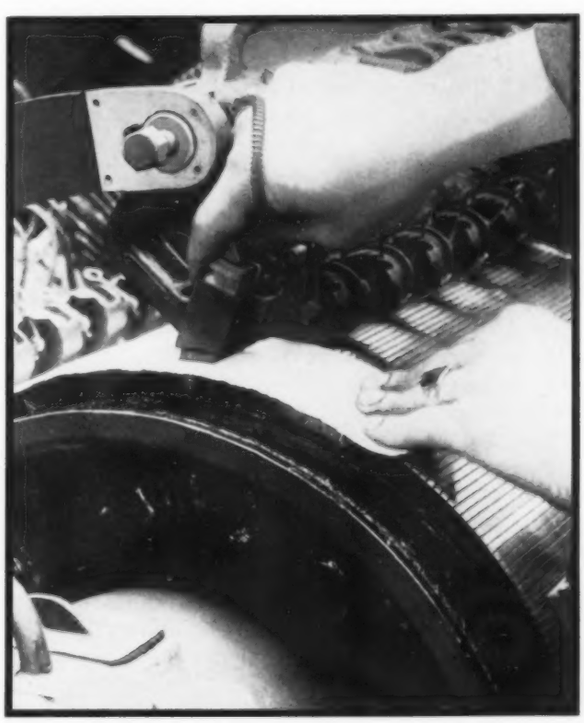
The brushes themselves must fit properly, not so tightly as to stick, and not so loosely as to shift position when running. Make sure that the grade used is correct for the application, using only the brush specified by the manufacturer of the motor. Make sure that the fit of the brush on the commutator extends across the face of the brush.

The spring tension on the brushes should be uniform so as to prevent selective action. The correct pressure will vary with the design of the machine and adjustments should follow the recommendation of the manufacturer. The brushes should be staggered in pairs of arms to prevent grooving of the commutator. Brush shunts should be kept tight and free from excessive corrosion so that current will be uniformly distributed to the brushes. Under bad conditions of corrosive atmosphere the shunts can be protected by dipping in melted paraffin or in synthetic red enamel or by covering with woven cotton tubing.

Resurfacing of the commutator should be done in a lathe, or with a grinding rig. As it is impossible to obtain a true surface with a hand stone, it should be used only as an emergency. Practically all up-to-date d-c machines have undercut mica in the commutators. This undercutting should be kept 1/16 in. deep.

Proper maintenance, as outlined in the foregoing, is important even in normal times. In these times when our war effort is demanding most of our critical materials, our manufacturing facilities and our manpower, the importance of an adequate maintenance program in steel mills cannot be overstressed. Such a program will do much toward maintaining peak operating efficiency and making existing critical materials last for the duration. It is always well to remember the old adage "An ounce of prevention is worth a pound of cure."

Figure 4 — A thorough maintenance program does not neglect brushes. Proper method of cleaning and surfacing is to press brush down on a strip of sandpaper placed between brush and commutator. Several passes should be sufficient, depending on brush condition. The sandpaper should be held flat against the commutator surface to prevent rounding of the brush end.



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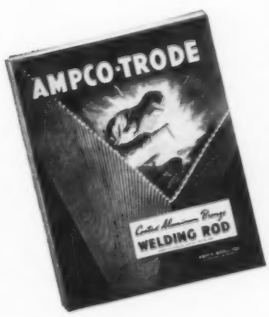

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Abstracts of Papers . . .

To be read at A. I. S. E. Annual Meeting, Pittsburgh, Pa., September 28-29-30, 1943

BLAST FURNACE BLOWING RATES

By E. L. Clair
Vice-President
Interlake Iron Corporation
Chicago, Illinois

This paper briefly discusses various methods that may be used to measure the proper wind volume for any blast furnace.

The need of blowing the maximum reasonable wind volume to produce maximum iron output in these times is apparent. This paper outlines various yardsticks which may be used to measure the maximum wind volume and therefore the ability to burn coke.

The observed fact that formulae used in the past for small furnaces, as for example the best developed furnace of 1914, do not seem to apply equally well for the modern large furnace is examined. The fundamental difference in furnace proportions is cited.

The blowing rate for nineteen furnaces in operation today is examined, and the unit blast volume measured at various furnace sections computed. Specifically, three different expressions for blowing rate are examined: (a) the wind volume in cfm per square foot of hearth area; (b) the wind volume in cfm per 100 cubic feet of furnace working volume; and (c) the wind volume in cfm per square foot of top area.

The blowing rate measured as above is then plotted, as related to furnace size as measured by hearth diameter, in order to show the possible consistent effect of increasing furnace size on the blowing rate.

The overall conclusion reached is that the blowing rate decreases uniformly with increase in hearth size, and with increase in furnace volume, as furnaces are now designed. It appears to be measured directly by stock line area.

Proper blowing rate at blow-in and the relationship between increasing wind volume and increasing ore load is then discussed. The wind volume and ore load as a percentage of full wind and full ore load is plotted against time in hours from the furnace start. This shows two empirical curves which have been developed from the data of many blow-ins, and are now used as standards by Interlake for any furnace.

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ROBOTS AND THE MANPOWER SITUATION

By F. Mohler
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General Electric Company
Schenectady, New York

In this time of emergency the shortage of manpower is becoming more and more critical. This subject is becoming one of prime importance, not only to our armed forces but to every industry and every phase of American life. It, therefore, seems fitting that the electrical engineers of the steel industry should examine carefully their own operations and do whatever possible to save manpower.

After careful study they should do whatever possible to put robots to work. A robot is defined as any automatic apparatus or device that performs functions ordinarily carried on by human beings, often operating with what appears to be almost human intelligence. Most people think of a robot as a complicated mechanism built to resemble a human being. However, there are many simple devices which are really robots and which perform functions to save manpower.

It is the purpose of this paper to describe various

means of saving manpower. It must be borne in mind that any apparatus built to save manpower requires manpower to build it. Therefore, one of the first considerations is to lay down a yard stick as to whether the manpower situation is helped or hindered. An attempt to do this will be made for future guidance.

Among the many methods of saving manpower to be discussed are: Signaling systems, meters and instruments, gauges, inspection equipment, automatic control, proper application of drives, and reduction in maintenance.

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PITCH AS AN OPEN HEARTH FUEL

By J. F. Wilbur
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Bethlehem Steel Company
Johnstown, Pennsylvania

During the last few years pitch has fast become one of the major open-hearth fuels. Tar from the by-product coke ovens has long been used in the open hearth, but within the last few months the need has increased for more creosote and tar-acid oils; in fact it has become necessary for the Fuel Administration to issue a directive that tar should no longer be used as a fuel. There are, however, a number of tar distillation plants in operation and the residue or pitch from the tar stills is burned in the open hearth. Now, all of the by-product coke-oven tar must be distilled and the pitch should be used as a fuel where it is best suited.

Then, too, there is the urgent need for conserving fuel oil, and pitch is an excellent substitute fuel. Nearly all steel plants have their own by-product coke ovens where the pitch is produced; hence, each gallon of pitch used will replace the equivalent amount of fuel oil and thereby relieve at least some of the difficulties of transporting and maintaining supplies of oil.

We believe that with the increasing use of pitch this is the opportune time to review the progress and development of pitch-burning facilities. In this paper, we endeavor to set forth such pertinent points as will stimulate discussion and bring about an exchange of experiences which should be profitable to all concerned.

Included in this paper is a brief description of two types of tar stills and of how they are operated. The still operation determines the physical properties of the pitch. The ultimate analysis of the pitch is dependent on the tar from which the pitch is made, and the analysis of tar changes with various coals. It follows, therefore, that the chemical analysis of pitch will vary as the coal varies. But the physical properties will remain as constant as the still temperatures are controlled. The melting point and viscosity are pertinent data in determining the means and precautions necessary in transporting the pitch, whether it be pumped through pipe line or shipped in insulated tank cars.

A loop recirculating system, well insulated, with an abundance of steam heating coils, is needed to deliver pitch to each individual furnace. Careful consideration must be given to the type of controls used at the furnace and the material used in valve seats and discs. Atomizing equipment must be such that the small openings will not plug easily with small particles of carbon, as most pitch contains 8 to 15 per cent free carbon.

The high percentage of free carbon in pitch produces a flame of high luminosity; whether or not this factor is responsible for faster melting (as compared with equivalent furnaces burning oil) remains to be proved. This is equally true of temperatures of the two flames, since preliminary measurements do not show conclusively that the pitch flame is the hotter. The fact remains, however, that pitch-fired furnaces are faster melting; one shop reported as much as 10 per cent more tonnage when burning pitch, as compared with production rates for the same furnaces when burning oil.

Pitch is a choice open hearth fuel. Numerous difficulties in using it have been overcome but improvements in burning and handling are still to be made. Its possibilities of increased open hearth tonnage offer the greatest returns as the desire for more tonnage is paramount in the minds of all steel men.

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CARBON DIOXIDE FIRE PROTECTION IN THE STEEL INDUSTRY

By C. A. Getz
Director of Research
Cardox Corporation
Chicago, Illinois

Recent advances in the carbon dioxide fire extinguishing art have taken place during the last four years. Men in the steel industry have investigated these advances and put them into use.

Carbon dioxide has been used as a fire extinguishing medium for many years. Nearly everyone is familiar with the small red cylinders of carbon dioxide and their associated projectors. These units have been widely used to "smother" small incipient fires encountered in connection with flamable liquids. Built-in fixed systems have also been used for a long time. In this case, 50 pound capacity cylinders were manifolded together and piped to the specific hazard protected.

The recent developments have been quite revolutionary and all of them cannot be published at the present time. By these new methods, carbon dioxide is stored in single pressure vessels in sizes varying from 500 pounds to as much as 125 tons capacity. These pressure vessels are maintained at approximately zero degrees Fahrenheit. The vessels are thoroughly insulated against heat entrance and the small amount of heat that does enter the vessel is removed by mechanical refrigeration.

This low-pressure, low-temperature liquid carbon dioxide has enhanced fire extinguishing properties. Increased dry ice snow yield upon release gives greater cooling capacity, great "reach" in direct application work, and uniform discharge rates.

These fire extinguishing systems are designed in such a manner that usually many hazards are protected from a single storage tank. Fire is automatically detected and the extinguishing medium is discharged into, or onto,

the hazard in trouble for the required length of time at the required rate. Immediate re-protection is available since the storage capacity can easily be large enough to afford double and even triple shot protection.

Many types of fire hazards are being protected by this new type carbon dioxide method. Special nozzles have been developed to handle quench tank and spray booth fires. Both indoor and outdoor electrical transformer hazards are protected by this type fire extinguishing system. Oil cellars, pipe tunnels, pump house, oil storage facilities and large electric motors are included in the list of steel mill hazards being protected.

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SPEED CONTROL AND BRAKING FOR A-C CRANES

By E. J. Posselt
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Cutler-Hammer, Inc.
Milwaukee, Wisconsin

Although many methods have been applied in the design of a-c hoist controllers they have not been generally acceptable because each method was limited to a few applications. Speed-torque characteristics of the conventional secondary resistor controller for wound rotor motors in general have been satisfactory for hoisting. The difficult problem has been to provide a simple method of control which will produce the desired characteristics for lowering operations. A new method of control will be described to show how speed-torque characteristics satisfactory for general application can be obtained with a standard wound rotor motor. It is not the intention of the author to include all the theory and mathematics which might be used to describe the evolution of this scheme but rather to explain as clearly as possible what the scheme is, how it functions, its speed-torque characteristics and something about its limitations. Any new device can be applied more effectively if its functions are clearly understood, therefore, a complete description is offered in a sequence that can be readily followed by all who are interested in motorized equipment.

Some of the methods used for operating a-c hoists are reviewed with comments regarding their comparative features and applications. These methods are the use of manual or automatically controlled loading brakes, regenerative braking, single phasing, direct current braking and counter torque lowering.

Unbalanced voltages impressed across the primary of a wound rotor motor with suitable secondary resistors will provide the desired speed-torque curves for lowering operations. Since unbalanced systems may be considered as two balanced systems rotating in opposite directions, such a system may be compared to two motors having a common shaft and connected for rotation in opposite directions. Then by adjustable separate control means a net shaft torque desired for driving or retarding a load is produced. This comparison helps to visualize the theory of unbalanced voltages as applied to this new method. A fundamental section of the wiring diagram is discussed with several sketches to show how an auto-transformer may be used to obtain the unbalanced voltages for the motor.

The elementary diagram of the control scheme is presented with an explanation of its operation. A novel method for obtaining dynamic braking in the off position of the master switch is included in the control scheme described.

A complete set of speed-torque curves are included to show the results which may be accomplished with this method of control. Theory is introduced where necessary to explain certain facts but this is usually secondary to a more direct explanation.

Other possible methods of providing unbalanced voltages for the motor circuit are mentioned but the main discussion is centered on the use of an auto-transformer scheme.

In conclusion speed-torque curves of the various methods described are compared to show the advantages of the new scheme for general applications. Certain limitations regarding the application of this method are pointed out. The use of this new control method for other purposes besides hoist controllers will also be of interest.

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FUEL SYSTEMS — EQUIPMENT AND CONTROL

By Franklin C. Frye
Superintendent, Steam and Fuel Department
Great Lakes Steel Corporation
Detroit, Michigan

This paper will deal with the fuel system equipment now being used at Great Lakes Steel Corporation. It will indicate specifically a procedure for burning both gas and oil in open hearth and re-heating furnaces. The subject matter includes an automatic dumping control for mixed gas in open hearth furnaces. It will discuss changes that were found necessary in present fuel oil burning equipment due to the change from heavy to light fuel oils. This involves handling, pumping, treating and heating of the substitution oil. This paper will endeavor to incorporate the changes which have been necessary in other fuel burning systems due to present emergency conditions.

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INDUSTRIAL ENGINEERING IN WAR PRODUCTION

By C. P. Spangler
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Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

Previous to the present war industrial engineering in the steel industry became stabilized into a process mainly of devising improvements in planning, routing and handling materials, studying means of reducing

delays in operating equipment and processes, setting standards and wages incentives for human effort and establishing budgets and cost control schemes. Mechanical and mathematical methods predominated and were the technique of the pre-war era.

War came on us over night and we were faced with a production speed problem as well as a drain on our manpower, all for the benefit of the armed services. From the government came the demand for speed and more speed. From the Army at Bataan came the cry "Too little and too late." Ultimate speed of production can come only from the combination of the best mechanical methods and the maximum cooperation of every man and woman in our mills. The second part of this combination is a job in personnel relations. The industrial engineer has a new factor added to his previous job if he expects to accomplish the maximum possibilities from his efforts.

Now the industrial engineer must conduct the same type of work as he did before and in addition must take on a personnel job which is outside the function of the personnel department. Wage incentive plans have not changed. But making them work to produce the best results is no longer just a matter of getting the approval of management and then notifying the men concerned. But the men themselves must be sold and the union convinced that the plan offers something to the men and is not just a speed-up scheme. Management-Labor committees, as sponsored by the War Production Board, are probably here to stay and we must get used to dealing with and through labor representatives if we are going to attain the maximum cooperation required to meet war production demands. This selling job is of great importance today, because the new employees who have come into the steel industry have not been educated in the pre-war steel mill school of a full days work prompted by initiative and interest. Job evaluation in order to arrive at correct basic pay differentials between various occupations, is one of the newer jobs of the industrial engineer, and now emphasized by labor's sensitiveness to pay rates. The industrial engineer is in a good position to help the personnel department devise training programs to aid the new employees, men, boys and women, in getting quickly into the swing of their jobs.

The industrial engineers who now look upon their jobs as dealing only with methods and mathematics are going to be blocked in making progress and the results will be obtained by those who are personnel minded, in striving toward the goal of management, machines and men — the goal, "Win the War."

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HOISTING OR SLING CHAINS

By F. W. Shaw
Columbus McKinnon Chain Corporation
Tonawanda, New York

This paper will briefly touch on the following important points:

1. Types of chain and the method of manufacture — iron, BBB and alloy.
2. Proper selection of chain for the job.
3. Safety rules to follow in the use of sling chains.
4. Inspection and inspection records.
5. What defects or weaknesses to look for in new and used chains.
6. Maintenance, repairs.
7. When to replace.
8. De-rating.
9. Discussion.

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PULVERIZED COAL FIRING OF METALLURGICAL FURNACES

By L. S. Wilcoxson
Executive Assistant
The Babcock and Wilcox Company
New York, New York

The necessity for converting oil fired furnaces of industrial and other types to coal firing in the interest of conserving oil for war needs is of great importance to the steel industry, as it utilizes a very considerable quantity of oil, among other fuels, in the heating of metallurgical furnaces of many and diverse types.

While it is true that a few of the many heating problems to be met in the various types of metallurgical furnaces cannot be handled with coal as a fuel as satisfactorily as with oil or gas as at present employed, primarily in view of the ash content of the coal, it is nevertheless the fact that with a great number of such problems pulverized coal can be employed as the fuel with equivalent and possibly better results in so far as the desired product from the furnace is concerned, and with materially better fuel economy, when proper consideration is given to the question of furnace design; the selection of coal to be used, and the degree of pulverization or fineness of the pulverized coal supplied to the furnace burners.

Pulverized coal installations on billet heating furnaces, forge furnaces, malleable annealing and malleable melting furnaces, as well as the handling of the raw coal to the pulverizer, the pulverizer installation for direct firing, and for a direct fired circulation system for firing pulverized coal are discussed and illustrated in some detail. The direct fired circulating system described is particularly applicable to the firing of pulverized coal to a multiplicity of small furnaces from a single pulverizer installation.

A comparison of the economics of typical oil and coal fired furnace installations is presented showing that for average conditions that prevail in a great number of instances the costs of conversion from oil to coal are rapidly compensated for by the savings resulting from the lower fuel costs when operating with coal.

The general fuel situation with the trend that might logically be expected in the future is reviewed to indicate that conversion from oil to coal at this time is not only the patriotic duty of those operators having furnaces susceptible of satisfactory conversion, but also is the means of obtaining more economical plant operation not only at the present time, but also in the future, when differentials in fuel costs in favor of coal will, by

present indications, be no less favorable, and will probably be more favorable than they are now.

The conclusions drawn are that with the proper consideration being given both to furnace design and the grade of coal being used, a large number of metallurgical furnaces now using oil as fuel can be economically converted to coal firing without affecting the furnace product, and by such conversion the operators will not only be in an advantageous position with respect to fuel supply during the present war period, but upon the cessation of hostilities they will be in a position to meet the conditions of fuel supply and economics that might logically be expected to prevail at that time.

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CENTRALIZED LUBRICATION FOR BLAST FURNACES

By A. J. Jennings
General Sales Manager
Farval Corporation
Cleveland, Ohio

The blast furnace department has some of the greatest natural hazards in the steel industry and lubrication of the bearings on the furnace tops is probably one of the most dangerous jobs that must be performed at regular intervals. In order to reach all bearings, many of which are 175 to 200 feet above ground level, men must climb all over the top structure and in the case of some of the sheave bearings, only a monkey or an experienced tight rope walker could reach these points. In addition, the men are directly exposed to the poisonous furnace gases for a large part of the time. In fact, oilers have been severely gassed while lubricating the skip hoist and bell mechanisms.

All of the bearings and especially the more important ones, should be lubricated at least once a day. Sometimes however, the gas is so bad, men cannot even go up on the top for two or three days at a time, and often when they do get up, they are only able to lubricate those bearings on the windward side of the furnace. In the past, this hazardous method has long been accepted as one that could not be avoided.

Safety rules require that two men always go up on the top — one to do the actual greasing of the bearings, and the other to watch him and also watch for gas fumes. In case gas is encountered, the second man attempts to get the oiler out of the danger zone, and to signal a third man who is on the job at the bottom, to bring aid.

A centralized lubricating system not alone keeps the men entirely out of the danger zone, by providing complete lubrication of all bearings from the ground level, but it also eliminates a principal source for gas leakage by giving proper lubrication to the packing seal on the distributor ring. Without adequate lubrication, this packing gland soon shrinks from the effects of the steam, gas, heat, and ore dust surrounding it. With a well-lubricated gland on the other hand, gas leakage is almost nil. We can report that on three different furnaces, seals are still holding perfectly after a production on each furnace of well over a million tons.

Some of the first installations on furnace tops were made back in 1930 and covered only the 25 or 30 bearings on the rotary distributor. Following these early installations, the use of centralized lubricating systems has been gradually extended to include all of the bearings on the top. A recent check-up shows that more than 50 furnaces are now equipped and materials are on hand for many additional installations as soon as the work can be done.

As a rule, records of repair costs in the average blast furnace department have not been broken down to show which items are chargeable to lack of lubrication and it is therefore, difficult to get accurate and reliable data. However, centralized lubricating system installations on blast furnace tops have not necessarily been made to save labor or repairs, but rather to insure continuous operation and to eliminate the hazards of hand oiling.

With the job of lubrication properly taken care of by the systems, it is no longer necessary to rely on the inexperience of an oiler for mechanical inspection of the equipment. Weekly inspections can be made by a competent man from the mechanical department, and further, given daily lubrication, it has been found that the equipment does not wear out so rapidly and the problem of inspection has been materially reduced.

In the past, many of the dangerous and hard-to-get-at sheave bearings just did not get lubricated at all. They were operated until they either froze or were completely worn out and a major repair or replacement was required. A saving of but $500.00 in these repairs, would pay for a substantial part of the cost of a lubricating system.

Also, while centralized lubrication on furnace tops is not employed primarily to save oiling time, it is a fact that the labor of oiling is reduced to a minimum. With two and sometimes three men, at least 30 minutes was required to lubricate all bearings, whereas with the centralized system one man does the job from the hoist room in a few minutes. It is true that the saving in man hours may not be sufficient to reduce the total number of oilers, but the man hours are saved and they are available to perform other work.

We have tried to point out that lubricating bearings on top of a blast furnace is a tough job because of the existing conditions and I believe we can all appreciate that if we had to do the job, we would not be too anxious about going up there either. With a central pumping unit located in the hoist house however, lubricating from 50 to 100 bearings way up on the top becomes a very simple and easy job to do and therefore, it gets done.

As a result of giving all bearings regular attention, centralized systems do a good job of lubrication — insure production — preserve equipment — eliminate down time — save critical materials — and provide complete safety for the oiler.

RECENT DEVELOPMENTS IN CORROSION STUDY AND CONTROL

By H. M. Olson
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The matter of corrosion in water systems has been of paramount interest during the past few years due to scarcity of metals and will continue for the duration and many years after.

It has been stated many times by leading authorities that we do not know so very much about corrosion and that is why there are so many papers and articles on it, but be that as it may, the problem is a huge one and changes almost from day to day, however it is my own opinion that some attempt is now being made to apply what has been learned in the past to the controling of some of the corrosion problems.

This paper will abstract information and data from over 50 of the best papers that have appeared during the past 5 years time covering all phases including theory; experimental; actual problems worked out; control equipment developed, etc. in the fields of atmospheric, water and soil conditions and in the preparation and use of steam and allied products.

Some actual experiences of the writer will be given and also some of the work of experimentation that is going on at the present time, including some information on what has been done and is hoped to be accomplished in the matter of corrosion control in U. S. Army posts and cantonments.

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METHODS AND EQUIPMENT FOR SUPPLYING POWER TO STEEL MELTING ARC FURNACES

By C. C. Levy
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Westinghouse Electric and
Manufacturing Company
East Pittsburgh, Pennsylvania

The proposed paper will discuss in a general way the joint difficulties of the user and the public utilities in finding the best methods of supplying power to electric steel furnaces. A review of the problems and the advancement made in overcoming them. Methods will vary with the type of installation, since it is obvious that the answer found suitable for the plant with only one furnace, may differ from the plant which has 1, 2 or 3 furnaces and will certainly differ from the large plant which requires an independent substation with its own power supply stepdown transformer.

Again subjects such as power factor correction and kw and kva demand limitation are of importance to the public utility, the user and the electrical manufacturer who applies the apparatus required.

Some discussion of improvements in apparatus will be included where the importance to the user makes it necessary; this will involve circuit breakers, transformers and possibly control. Some consideration will be given to the future developments which are indicated in circuit breakers and the possibilities of future transformer design for this application.

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RELAYING OF ELECTRICAL DISTRIBUTION SYSTEMS IN STEEL MILLS

By L. L. Fountain
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East Pittsburgh, Pennsylvania

In keeping with the trend toward the ever increasing size of things, steel mills have grown until some of them require power supplies that would be suitable for a medium sized city. Such concentrations of power present problems that are usually considered only in the category of the utility central station systems. Most steel mills generate sizable blocks of power in their own plants besides being frequently tied in with a local utility either for supplementary or stand-by service.

The distribution of this power to the various points in the mill, requires and gets serious consideration from the standpoint of economy and continuity of service. The last mentioned is always forcing itself into the limelight since there has been to date no certain means of preventing faults on power systems. To be sure great strides have been made in the improvement of the quality of apparatus and power transmission means so that very few faults are due to their failure. They occur nevertheless and must be coped with.

Modern relays, properly applied to a well designed distribution system, can go a long way toward minimizing the effect of faults on the continuity of the power supply to various loads in the mill.

There are many types of distribution systems but they are made of one or more of the following types of transmission lines:

a. Radial
b. Loop
c. Parallel
d. Tapped
e. Busses

The application of relays to protect each of these types involves a different analysis in each case and usually a different type of relay.

a. Overcurrent
b. Power directional overcurrent
c. Impedance measuring
d. Differential
e. Pilot wire

f. Overvoltage
g. Undervoltage

These can be put in two main groups of high speed and slow speed. High speed using one cycle to operate and the slow speed from six cycles up. There are also other classifications that can be made such as, phase relays and ground relays.

The proper application and choosing of the correct relay for the type of line can follow no set rule but each case requires careful analysis. The following usually has to be taken into consideration.

a. Minimum fault currents
b. Maximum fault currents
c. When the system is grounded both phase and ground currents in a and b.
d. Voltages, both phase and ground
e. Phase angle between currents and voltages under fault conditions.

Where these values cannot be readily calculated valuable time can be saved by making use of both the a-c and d-c calculating boards.

The low voltage system (460 volts) sometimes requires careful consideration in its relaying ,especially where the popular cascade method of breaker formations are used. Accurate discrimination between faulted and unfaulted lines is sometimes difficult, in that short lines and fast opening breakers are involved. Also the value of fault current varies so rapidly with its proximity to the distribution bus that frequently current as well as time discrimination must be utilized.

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LUBRICATION OF NON-METALLIC BEARINGS

By G. E. Reiser
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The art of manufacturing bearings of the phenolic type has been broadened with the passing of each year, and their use has gradually been extended from their first installations on light loads at relatively high speeds to heavy loads and moderate speeds. The quality has also been improved to the point where they are adaptable for most conditions in present day applications and after more than 10 years of extensive use, synthetic bearings have now become definitely established in steel mills. Because their characteristics are entirely different from those bearings of the metallic type, it is necessary for operating men to become familiar with a few simple requirements before they can use them successfully.

This discussion, covering installation precautions, water and grease lubrication is composed of excerpts from previous papers as well as information from other sources, and should promote a better understanding of the lubrication of composition bearing.

PLANT DISTRIBUTION SYSTEMS FOR OXYGEN AND ACETYLENE

By Herman Ullmer
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The extensive use of the oxy-acetylene process of welding, heating, and cutting metals which occurs throughout the production and maintenance departments of a steel plant, requires an efficient system for the supply of these materials to the plant and their distribution by piping to the locations of use within the plant. Systems for this purpose, now in service in a large number of steel plants for a number of years, have demonstrated that the lower cost and other benefits of piped service from a central supply unit amply justify the expense of the installation required, and that such systems provide dependable and safe operating service.

The design of oxygen and acetylene distribution piping systems requires a thorough knowledge of the operating characteristics of the oxy-acetylene equipment used, and an intimate understanding of the mill premises and operating conditions. The most important considerations in the design of the piping systems are: the extent to which it will be practical and economical to supply the oxy-acetylene operations in the plant by piped service; arrangements for interconnecting the individual runs of piping to provide a well integrated system, convenient for operation and maintenance; selection of protected locations for placing the piping; investigation and accounting of the oxy-acetylene operations to be served for determining the pipe flow load requirements, operating pressures and outlet equipment to be provided for; sectionalization of the system for pipe size reduction and location of acetylene flashback arresting devices; allocation of allowed line pressure drop and determination of pipe sizes by flow formula; and the use of receivers or other special provisions for supplying high flow rate requirements.

Trouble free performance and satisfactory service life are assured by construction practice conforming with the high quality standards called for in the installation specifications which have been developed especially for oxygen and acetylene distribution piping systems. These specifications provide for the use of black steel pipe assembled with oxy-acetylene welded joints. Screw fitting is confined to connection joints for station outlet and line equipment. Station outlet valves are a special design, packless, diaphragm type provided with an outlet threaded to conform with the special standard used for connection nuts on oxy-acetylene equipment. Pipe and fittings for oxygen service must be washed free of oil and grease. Adequate corrosion protection is afforded by painting above ground, and by coating and wrapping piping placed underground. Exacting leakage tests including a soap-suds test of all joints and a 24 hour standing pressure test are stipulated.

Operating supervision should confine service use to accredited oxy-acetylene equipment operators and provide for regular inspection to insure that outlet valves are closed and capped when the outlets are not in

service. Warning signs at station and line shutoff valves are dependable in avoiding tampering by uninstructed employees. Maintenance of the piping is normally a small item but should include periodic leakage tests, especially of threaded connections and packed type shutoff valves. Operators' hose and equipment should also be subject to periodic tests to keep them leak free and in good working order.

Most of the steel producing and steel fabricating plants in the United States are equipped with central supply units and distribution piping systems for both oxygen and acetylene. Similar service exists in practically all of the shipbuilding yards, machinery manufacturing and various types of industrial plants.

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BAR MILL ARRANGEMENT AND PASS DESIGN

By R. E. Beynon
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South Chicago, Illinois

Bar mills are the most common type of rolling mills, and also among the oldest, dating back to 1728 or even earlier. This paper traces the development of the bar mill through the early designs up to the modern installations, giving typical layouts for each type. A number of foreign mills are included.

The competent parts of the mill are reviewed, including furnaces, mill housings, guides, rolls and hot beds.

The second part of the paper deals with roll design for roughing, leader and finishing passes in bar mills, and covers the various methods of reduction used in the rolling of rounds, squares, flats, hexagon, octagon, and small shapes. A large number of pass layouts are illustrated.

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A-C AND D-C DRIVES FOR DRAW BENCHES AND WIRE BLOCKS

By R. A. Geuder,
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The Reliance Electric & Engineering Co.,
Cleveland, Ohio

Electrical equipment for both draw benches and wire blocks comes in for extended discussion and analysis in this paper.

The operation of modern bar benches is covered with particular attention to the overall mechanical and electrical features essential to quality production.

Seven a-c and two d-c combinations of electrical drives are listed and the advantages and disadvantages of each enumerated. Included are the following:

1. a-c squirrel cage single speed drive;
2. a-c squirrel cage motors, 2-, 3- or 4-speed, non-accelerating;
3. a-c squirrel cage motor, 2-speed, accelerating type;
4. a-c slip ring motor drive;
5. a-c slip ring motor with unbalanced secondary control;
6. a-c squirrel cage motor with eddy current clutch;
7. a-c squirrel cage motor driving hydraulic units;
8. d-c motor with 2 to 1, 3 to 1 or 4 to 1 speed range;
9. d-c motor with variable voltage supply.

The discussion of wire blocks has been divided into four parts:

1. single head bull blocks;
2. single head continuous blocks;
3. multiple head continuous blocks;
4. multiple head continuous blocks with multiple motor drive.

The advantages of variable voltage on multi-motor wire blocks, particularly for installations in plants having a restricted amount of direct current power or none at all, are itemized and the possibilities of extremely wide speed ranges with this type of drive are outlined.

This system, in the opinion of the author, lends itself to an economic combination of motor generator set which will make use of over-voltage for high speed, light load conditions and provide normal voltage for heavier load, normal current operations.

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BUILDING SAFETY INTO A STEEL PLANT

By H. J. Griffith
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Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

The first step in any industrial accident prevention program consists of the elimination of physical hazards due to unguarded machinery and equipment, improperly planned layout and unsafe building conditions. Every effort is being put forth to remove, so far as is possible, these hazards in steel plants today. Large sums of money have been expended for the installation of mechanical safeguards and safety devices and for the replacement of unsafe equipment. The reason for this is obvious. If you do not show the men by some visible means, you cannot expect to obtain results. The aim is to have all machinery and equipment as fool-proof as possible. All plans for new structures to be erected and new machinery to be installed are checked in an effort to exclude all unsafe features and incorporate the most up-to-date safety principles. Plans are checked by the engineering department and when in doubt, they are referred to the safety department. When our present strip mill was constructed to get the 15 in. clearance between the end trucks on cranes and building columns necessary for safety, an additional $50,000 was required. This will indicate to what extent management will go to protect human life.

Safety goggles are furnished to all employes whose work subjects them to danger of injury to the eyes. Fireproof protective clothing is provided for employes in departments where there is possibility of burns from molten metal or hot rolled material; also, protective

hats are furnished where necessary. The wearing of safe toe shoes, capable of withstanding heavy blows from falling objects without injury to the feet, is encouraged and in some departments necessary to employment. The use of this protective equipment is constantly preventing many serious injuries.

At each works we have what is known as a central safety committee which is composed of all department heads, such as departmental superintendents (steel works superintendent, blast furnace superintendent, rolling mill superintendent, etc., chief engineer, head of employment department, etc.). This committee meets monthly, the superintendent of safety and welfare of the works acting as chairman. The general superintendent of the plant is on this committee and he or one of his assistants always attends. This committee shapes the general safety policies of the works and passes on all items of major importance. At one of our works a weekly safety and cost meeting is held. This meeting is held on Friday. Any foreman having a lost time case to any of the employes working under him has to come to this meeting and explain to the superintendent and those present just how the accident happened. This has a splendid effect in that no foreman cares to appear before the superintendent and department heads.

Each department has its own safety committee which is composed mainly of the principal foremen in that department. Some of these committees meet weekly, others bi-weekly. At these meetings departmental safety matters are discussed. This includes both the correction of physical hazards and the correction of unsafe practices.

Every foreman holds periodic safety meetings with his men. Some foremen hold weekly meetings, others bi-weekly, and some monthly meetings. On the average, each workman attends three safety meetings held by his foreman every two months. Monthly accident reports and results of safety contests, if such have been held, are discussed at these meetings. Foremen's safety news letter containing information which is of interest to all employes are issued periodically by the safety department. These news letters are often used as subject matter for foremen's meetings of workmen.

To further maintain interest in no-accident records in smaller departments, a certificate signed by the general superintendent and the superintendent of safety and welfare is awarded to each department going through the month without a disabling accident. On this certificate are placed gold seals for each month during the year which this department completes without a lost time injury. A great deal of interest has been taken in the winning of these certificates.

In addition to safety meetings, safety posters from the National Safety Council are displayed on illuminated bulletin boards throughout the plants. These posters are changed weekly. Supplementing this service at most advantageous points, Jumbo posters, obtained from the National Safety Council, are displayed. Each new employe is given a pamphlet containing general safety rules and the company's policy on safety when he is employed.

All lost time accidents are investigated by the safety department, and an attempt is made to place the responsibility in each case. A court of inquiry is held by the safety department in all serious cases and all witnesses are called in and their stories recorded. The department head also attends this investigation with all foremen involved. After all of the facts have been procured, the safety engineer and department head place the responsibility and recommend what disciplinary measures, if any, shall be taken in the case. The chief reason for these investigations, of course, is to eliminate a repetition of a similar occurrence.

A campaign is carried on against unsafe practices. Any foreman who observes a workman doing a task in an unsafe manner reports same on an unsafe practice report form. The circumstances of the case are related together with the measures taken to correct the practice.

Plant inspections are made continually by members of the safety department. In addition, some of the departments have organized safety inspection committees to inspect their own departments for physical hazards and unsafe practices. Some inter-departmental safety inspections are also arranged whereby several men from one department inspect a department other than their own for conditions and practices which are liable to cause accidents.

In 1930 we found after investigating accidents, which were numerous at that time, that our foremen were not as familiar with the general safety set-up and rules as they should have been; so we decided upon a foremen's discussion class. These classes are attended by some 1,300 foremen and are led by the safety engineer. Each foreman is required to attend class once a month, and these classes last three-quarters of an hour.

In the final analysis the success of any safety program depends on top management. If top management has been sold as to the human, physical, and financial benefits derived from a sound safety program, there is no doubt about its success.

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ELECTROLYTIC TINNING OPERATIONS

By H. P. Munger
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Republic Steel Corporation
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Since an electrotinplating line is extremely complicated, only a brief description can be given of the units. Republic Steel's two lines were designed in order to secure a maximum of flexibility in the production of the various products required by tin plate users. Discussions of individual parts of the line could be made the subjects of technical papers. The electrotinplating line consists of the following: entry zone including uncoilers, shears and welder; processing zone including electrocleaner, pickler, autoguide unit, scrubbers and horizontal type plater; finishing zone including nickel-silver brush brightener, hot rinse, flow brightener, chemical treatment and emulsion oiler; recoiling zone including pusher pinch rolls, snip shears and reels; shearing zone including a tension puller and uncoilers, Hallden shear with a classifier and three pilers.

The horizontal type plater was selected because of its ease in threading, lower voltage required for plating, ease of plating different coating weights and even different metals on two sides of strip. The Du Pont halogen electrotinning bath is being used in the plater.

Each line receives its a-c power from a unitized substation located as near as possible to the center of the electrical load. Rectifiers are used throughout the line for low voltage power. The electrocleaner rectifier is 4,000 amp at 18 volts while the plating rectifiers have a capacity of 120,000 amp at 6 volts for each line. These two lines constitute the largest single installation of low voltage rectifiers for electroplating in existence today. The line is powered with 230 volt d-c motors using the variable voltage Ward-Leonard system for speed control. The auxiliary constant speed motors are 440 volt, 60 cycle, 3 phase. D-c control is used throughout. The flow brightener consists of six 200 kilowatt, 200,000 cycle high frequency oscillators connected to six heater coils.

Side trimmed strip is delivered to the electroplating line. The electroplating line proper is designed to operate at speeds up to 1000 feet per minute. The shearing line is operated in tandem with the plating line for speeds under 600 feet per minute and will be operated as a separate unit at higher speeds.

In order to eliminate fogging of the plate it is necessary to watch each operation to insure the complete absence of dirt, crystallized salts, etc. which will form a film that masks the reflectivity of the melted tin. It is also necessary that the electrodeposit of tin be suitable for melting.

At the present time, enamelled electrotinplate with approximately 0.5 lb per base box coating is being used for vegetable packs and closures. Milk cans are being made of 0.75 lb per base box plate. It is believed that after the war, electrotinplate will find a variety of uses for which it is ideally suited.

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MODERN TRENDS IN BLAST FURNACES

By Frank Janecek
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Republic Steel Corporation
Cleveland, Ohio

This paper surveys the period from 1916 until the present, plotting the number of furnaces in existence, the number in operation, the total production and the production per unit. It is interesting to note that while the number of blast furnaces steadily decreased from a maximum of 437 in 1918 to 228 in 1941, the production capacity has increased considerably. The average tons per furnace day has grown from less than 400 to about 800 during this same period.

This gradual enlargement of furnaces has required changes in furnace auxiliaries. More stove capacity is needed, and cleaner gas for use in the stoves. Improved gas burning equipment has proven essential. Recording instruments and automatic controls have received due recognition.

Mud guns, automatic stockline recorders, pug mills, sintering plants and thickeners have all come to have a responsible part in the complete operation.

The sizing of raw materials has been found to be particularly advantageous.

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BLOOM AND BILLET MILLS AND THEIR ROLLS

By D. L. Eynon and F. C. T. Daniels
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Pittsburgh, Pennsylvania

The paper reviews roll designs and mill layouts for two-high reversing bloom and slab mills, three-high blooming mills, and a number of mills of more or less special design. Billet mills, of two-high reversing, three-high and continuous design are also discussed.

Roll hardness is a compromise between strength, roll slippage and wear, and the desired characteristics, which depend on the work the roll must perform, are obtained in various ways.

The main difficulties encountered in the use of blooming mill rolls are fire-cracking, excessive collar wear, slippage, steam cutting, breakage, and holes or streaks of segregation.

Rolls for billet mills require much the same consideration. In the continuous mills, rolls are varied from one stand to another, according to the nature of the duty.

The paper includes a large number of illustrations of mill layouts and roll passes.

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CARTRIDGE CASE STEEL

By Lieut. R. E. L. Stanford
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It is believed that it would be beneficial if the steel men understood more fully some of the manufacturer's problems in fabricating the steel shipped out as blanks into finished cartridge cases. For the benefit of those who have not had the opportunity to study at close hand the fabricating procedure and the functioning requirements of the finished case, there is outlined briefly some of these points and shown examples of some of the more common types of troubles experienced, and in the discussion period, requests will be made for suggestions of means of eliminating some of these problems. The Army and the cartridge case fabricators, particularly, will be most grateful for any help that can be given.

As a bit of background, the production of a steel cartridge case is a problem that has intrigued ordnance engineers for the last 25 years. Brass has been and is the ideal metal for this use since cartridge cases were first adopted about 75 years ago. This was logical for many reasons; brass was a high purity metal even then, was comparatively easily worked, and the high physicals required were easily obtained by cold working. The greatest advantage, however, in the use of brass for this application was its comparatively low modulus of elasticity, which results in physicals of only about ⅔ of those required of a steel case to do the same job. The high purity steel required, thanks to the wonderful cooperation of the steel industry, was soon obtained; the technique of deep drawing to shape was soon worked out but we are still fighting that high modulus of elasticity factor of steel.

A cartridge case looks like a tin can, actually it is a very highly technical mechanism performing a number of functions:

a. First, it is a container for the propellent powder;

b. Second, it is a rigid support for the relatively heavy projectile, and in some guns with automatic feed mechanisms this is a tough requirement;

c. Third, it contains the primer element which ignites the propellent powder, in every accurate alignment with the firing pin in the block;

d. Fourth, the case must act as a valve, sealing the breech of the gun against the escape of the propellant gases. These gases are generated to extremely high pressures almost instantaneously, and any escape of the gases past the breech not only reduces the energy against the base of the projectile but also endangers the gun crew. That case has got to work every time;

e. And fifth, after performing the above functions the case must be readily removed from the gun to allow loading of the next round. In this game, a jammed gun can be awfully serious.

These points require that the utmost engineering skill and constant vigilance of all concerned be devoted to every phase of the manufacture of a case from the open hearth to the loading plant.

Attention is called to some of the observations that have been made on the steel making practice and passed on for what they are worth. To put it bluntly, the best steel made just barely meets the stiff requirements to which it is put. The very severe drawing operations necessary to produce a case, and the factor that a failure to function due to an inherent steel defect may cause loss of life and effect the tide of a battle, require that the steel be of "magnaflux" quality if possible.

Relative to the composition requirements of the steel, these limits were not arbitrarily set up, as C and M, if too low, bring the physicals down to a point where the case fails to function, and if too high, it can't be drawn. These limits were arrived at as a compromise between what was required and what could be supplied. Al is required to give a fine grain.

Apparently the best method of steel making is casting in big-end-up hot top molds, with a liberal cropping of the primary and secondary pipe to eliminate laminations and segregations in the slab. Slab conditioning is most important as many of the defects causing trouble in the case plant can be eliminated in the slab.

In the rolling mill, aside from the more obvious factors of preventing sharp, deep scratches and maintaining dimensional tolerances, a point which is not so obvious but of primary importance is the finishing and piling temperatures as this directly influences the efficiency of the spheroidization in the box anneal. Micros, showing examples of steel as hot rolled and as spheroidized finished at the proper temperature and piled not too hot, show a good spheroidization with a comparatively short time anneal; micros showing the steel as hot rolled and after spheroidizing show a poor spheroidization due to a finishing temperature too hot; and micros showing the steel as hot rolled and after spheroidizing show the effect of a poor spheroidization due to banding.

Robert Burns of the Armco research department did a good stroke of work in determining some of the differences between various steels now being supplied. One of the 20mm manufacturers was getting steel from six different mills and although they were all manufactured to the same specification, they varied widely in comparative workability. Mr. Burns was given a number of samples on types of steel without being told where they were from but with them classified by comparative ratings with regard to:

a. Die life and coining properties;

b. Metal defects;

c. Cracked edges in the top of the cup

d. Relative difficulty in holding bottom thickness dimension.

He found that:

a. The carbon content and hardness of all of the blanks were within reasonable limits, the hardest material submitted being that with the highest carbon content and only fair spheroidization;

b. The Meyor "N" values which represent work hardening capacity all fell within a narrow range and did not indicate any positive difference in this property between the various brands of steel. He did show, however, that the material with the highest "N" value had the coarsest grain size.

c. There was little difference in the cleanliness of the steel in the small blanks submitted for micro examination except that one steel which had a very high percentage of rejects for metal defects looked awfully dirty under the microscope.

d. Decarburization on all the blanks was spotty with at least one blank in each group having .010 decarburization which is apparently not objectionable. It is estimated however that .010 decarburization should be the maximum allowed.

e. An outstanding point was that the worst steel for coining properties was the one which showed the most banding and that all the materials had fairly good spheroidization except this one brand of steel which had a banded structure.

Samples of various types of defects are presented for discussion.

SLINGSHOT...

with a 1,000,000 pound wallop!

From the deck of a ship a plane is shot into the air ...catapulted by a giant "sling" that imposes a load of about one million pounds on the Hyatt Roller Bearings in its mechanism.

What a wallop!

And what a bearing...that possesses the necessary design, precision and toughness to handle such load extremes!

Years of peacetime experience, in applications undergoing parallel punishment...like ingot cars, mill motors, shaping presses, railroad journals, etc. ...have enabled Hyatt to "inbuild" the stamina needed to take loads as they come.

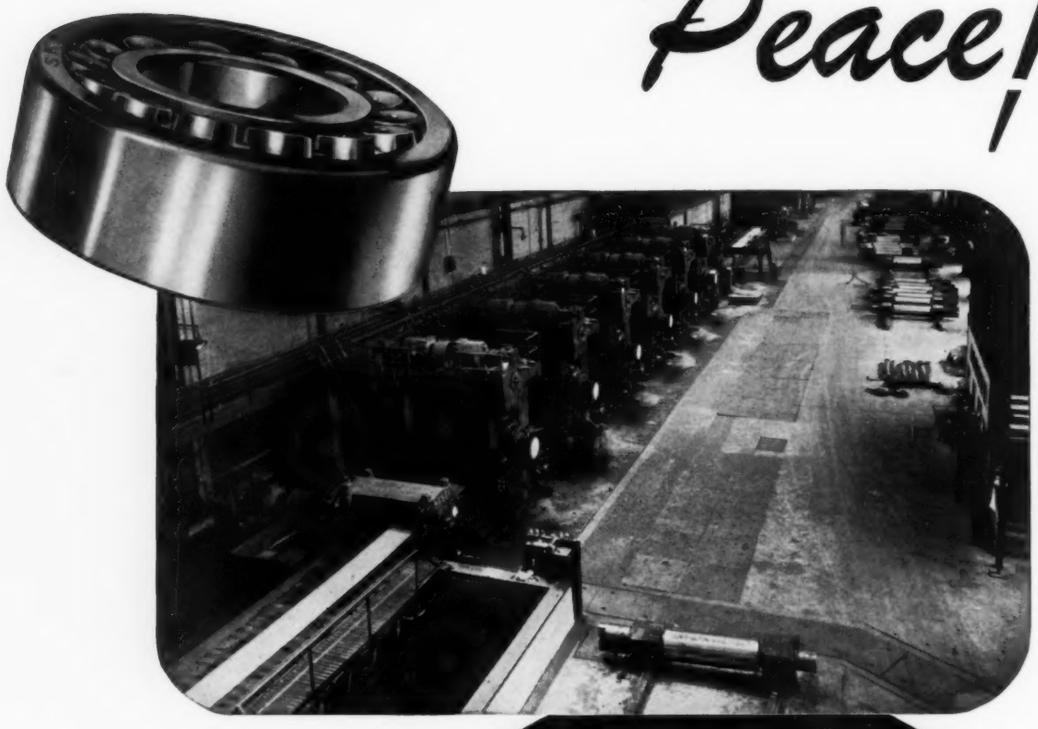
In the battle of production...as on the battlefield...Hyatt Roller Bearings are fighting to win this war.

Fighting against friction...and for America!

Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

FOR *War* AND *Peace!*



The SKF Back-up Roll Thrust Bearings for this 79″ Hot Strip Mill were built *yesterday* during Peace, and are now working to restore it. They will still be working when Peace returns despite the fact that War-time is also "hell on bearings."

5357

SKF INDUSTRIES, INC.
PHILADELPHIA, PA.

SKF
BALL AND ROLLER
BEARINGS

● SKF BACK-UP ROLL THRUST BEARING

Quenching a tray of aircraft fasteners, after Homocarb carburizing. Insert shows fasteners full size.

NO MATERIÉL REJECTED

From This L&N-equipped Heat-Treat

To help other war-production plants see how rejects in heat-treatment can be almost entirely ended, one of our customers allows us to present these pictures of his heat-treat.

This plant relies entirely on the Homo Method for mass-production carburizing, nitriding and tempering, and on the Vapocarb-Hump Method for tool-hardening. Two of many typical items are shown above.

"Taking the guesswork out of tool-hardening" might be described as the function of the Vapocarb-Hump Method, as applied in the picture below. The results are: Longer life per tool; fewer tools to make; less tool steel used; practically none wasted because every tool becomes a maximum producer.

The aircraft fasteners need only the thinnest carburized case. They are accordingly quenched almost as soon as they reach full temperature; yet are highly uniform because the Homocarb Method gives uniformity of temperature and carburizing action during the heating-up as well as during the soak.

Heat-treater checks the dissociation of ammonia in the Homo Nitriding Furnace. A high-quality process, nitriding by the Homo Method easily meets the most stringent acceptance tests.

A Slogan For All Americans

Aristocrats of war materiél, these bomb-nose forgings are shown being Homo-Tempered to give them their extraordinarily uniform draw.

The fuse-noses are metallurgically more intricate. They are forged from No. 4140 steel, and require deep hardening, scale-free without carburizing. This operation is performed with great success in the Homocarb Furnace, where uniformity of both atmosphere and soak temperature are provided for a relatively long time. Noses then go to the Homo Tempering Furnace where they are drawn back with great exactness. The final test of hardening and tempering success comes when the noses are finish-machined both rapidly and accurately. Rejects chargeable to heat-treatment are almost unknown.

Further information about the L&N Heat-Treating Methods will be gladly furnished by an L&N engineer. Or, if you prefer a well illustrated, simply written catalog, please specify your problem.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl Ad T-620(17)

Transformer Fundamentals

...that insure unfailing power supply to *war industries.*

The fundamental improvements outlined below are the result of Pennsylvania's continuous research and development to assure greater transformer reliability, lower operating costs and longer life! They are but a few of the many improvements to be found in Pennsylvania Transformers.

23,500 KVA
55°, 115 KV
3-phase

. . . Possess Maximum Inherent Strength

In a circular coil the tension of each turn of wire is uniform throughout its length. No coil of any other shape possesses this quality.

The turns in a circular coil are wound tightly without excessive tension on the wire—thus eliminating the possibility of stretching the winding and injuring the insulation. This added safety is inherent in Pennsylvania's circular coil construction.

. . . to withstand short circuits

All coils of the helical and pancake type are precompressed to such an extent that no further compression can take place under the most severe short circuit. This definitely precludes any possibility of the coil stack moving or distorting under short circuit.

The ability of the coil to maintain its shape under the prescribed pressure is your guarantee that the transformer will withstand short circuits.

. . . with Silver-to-Silver Contacts

Pennsylvania's straight line tap changer with its silver-to-silver contacts is capable of carrying heavy overloads without overheating and is able to withstand "dead" short circuits without detrimental effects.

Tests have been made to fully prove these characteristics, the tap changer being subjected to 100,000 full operations—more than would occur during the normal life of the transformer.

Pennsylvania TRANSFORMERS

Pennsylvania TRANSFORMER COMPANY

808 RIDGE AVENUE, • N. S., PITTSBURGH, PA.

CONTINENTAL Rolls...

TOUGH AS A MARINE
TEMPERED FOR ACTION

THE ability "to take it"—even under pressure—which has earned for the United States Marine the reputation for being an invincible fighter, has won Continental Cromonite Rolls a reputation as well. A reputation for speeding plate and strip steel production for tanks, ships, planes and scores of other uses.

Pioneered by Continental, Cromonite hard alloy chill rolls are today the choice of steel mills where uniform, satin-smooth, scale-tight finishes are required.

They last longer—stand up under the most severe high-speed operation.

CONTINENTAL ROLL & STEEL FOUNDRY COMPANY
CHICAGO • PITTSBURGH

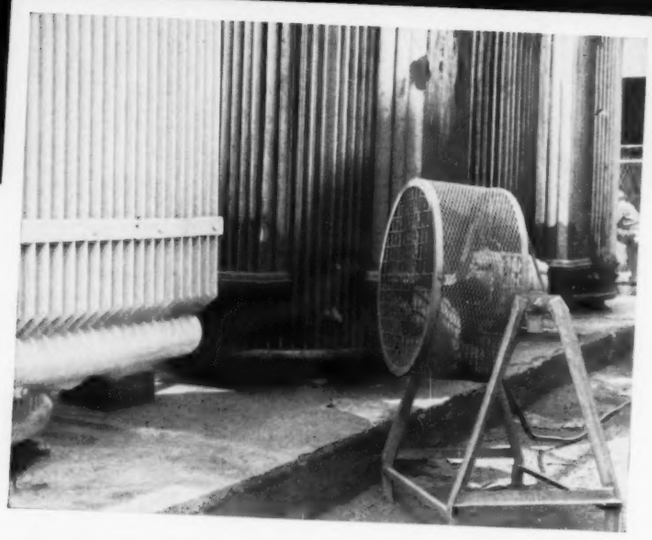
For custom built Rolls, Rolling Mill Equipment, Carbon and Alloy Steel Castings and special machinery of many types consult Continental.

CONTINENTAL ROLL & STEEL FOUNDRY COMPANY

Let Truflo Fans . . .

Help keep your workmen on their toes

Portable Fan No. TF-100, recognized as standard in many of the country's largest mills. Sizes from 12 in. to 36 in. in diameter.



Portable Fan No. TF-300 in operation, cooling large transformers in strip mill.

Crane Cab Fan, for cooling crane cab interiors and other confined areas. Available in 12 in. and 18 in. sizes, adjustable both horizontally and vertically.

Portable Fan No. TF-300W. Angle iron support adjusts for vertical or horizontal discharge through almost 360°.

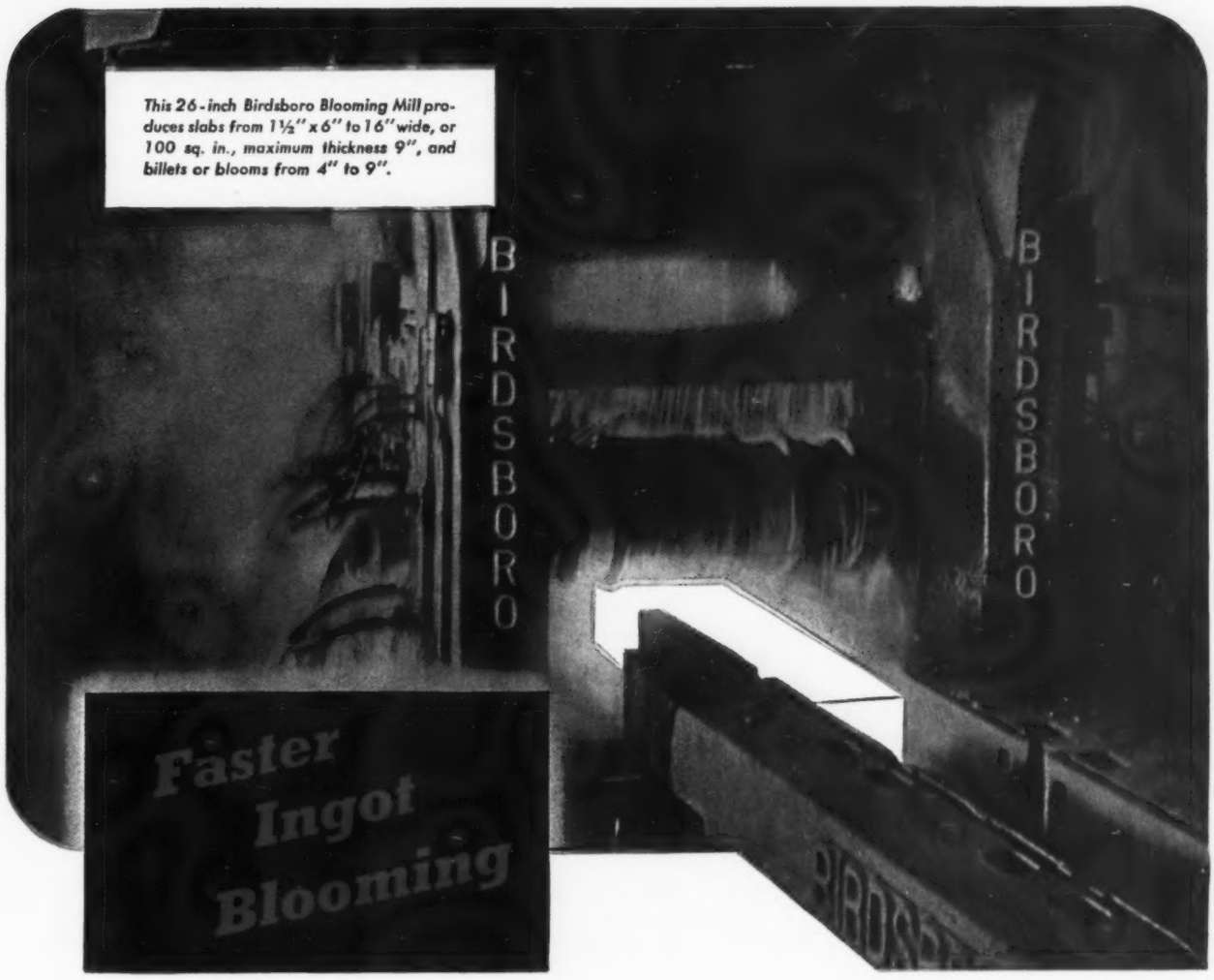
It's more important now than ever before to keep your workmen comfortable. For comfortable workmen are more efficient, produce more work in a given time.

Truflo Fans can help you keep your workmen on their toes. All Truflo Fans are designed and built correctly for efficient, economical operation — they move more air per dollar. Write for free literature on any of the following styles:

Portable Cooling Fans • Crane Cab Fans
Wall Fans • Exhaust Fans • Blowers
Roof Ventilating Fans • Pent House Fans

TRUFLO FAN COMPANY

554 MAIN STREET HARMONY, PA.


This 26-inch Birdsboro Blooming Mill produces slabs from 1½" x 6" to 16" wide, or 100 sq. in., maximum thickness 9", and billets or blooms from 4" to 9".
BIRDSBORO
BIRDSBORO
Faster Ingot Blooming

with Birdsboro Rapid Two-High Reversing Blooming Mill . . .

for blooming ingots of mild, tool, non-corrosive, automotive, aircraft and special purpose steel

to square, round and rectangular blooms and slabs

with the proper reductions required by the various grades of metals

within time limits the rolling temperatures permit.

Special features of this Birdsboro Rolling Mill — quick reversing, fast screw-down and rapid manipulation — provide the exceptional speed that is demanded by war-pressed production. Yet their low installation cost, low maintenance cost and low power consumption assure the economy that will be needed after Victory is achieved.

If yours is a rolling problem — of either the present or future — it will pay you to consult Birdsboro.

BIRDSBORO STEEL FOUNDRY AND MACHINE COMPANY, Birdsboro, Pa.

BIRDSBORO

STEEL MILL EQUIPMENT

FAMOUS BUM GUESSERS

Hermann
(LUFTWAFFLE)
Goering

He boasted that United Nation's planes would never bomb Berlin. How's the air down in those Berlin shelters these days and nights . . . eh, Hermann?

American industry has never overlooked one important fact. You can't run machines on guesswork. Every Penola lubricant provides an extra margin of safety over actual operating needs. A good reason why the steel industry uses more Penola greases than any other brand.

PENOLA LUBRICANTS
PITTSBURGH, PA.

Penola
Reg. U.S. Pat. Off.

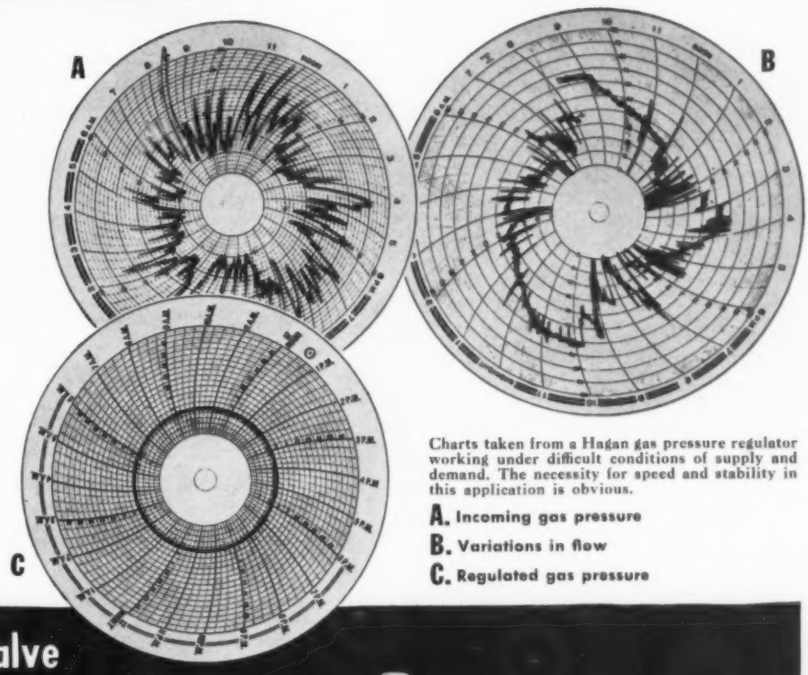
NEW YORK
CHICAGO
DETROIT
ST. LOUIS

LUBRICANTS FOR THE STEEL INDUSTRY SINCE 1885

Hagan Control—

RELIABLE · STABLE · FAST : ACCURATE · POWERFUL

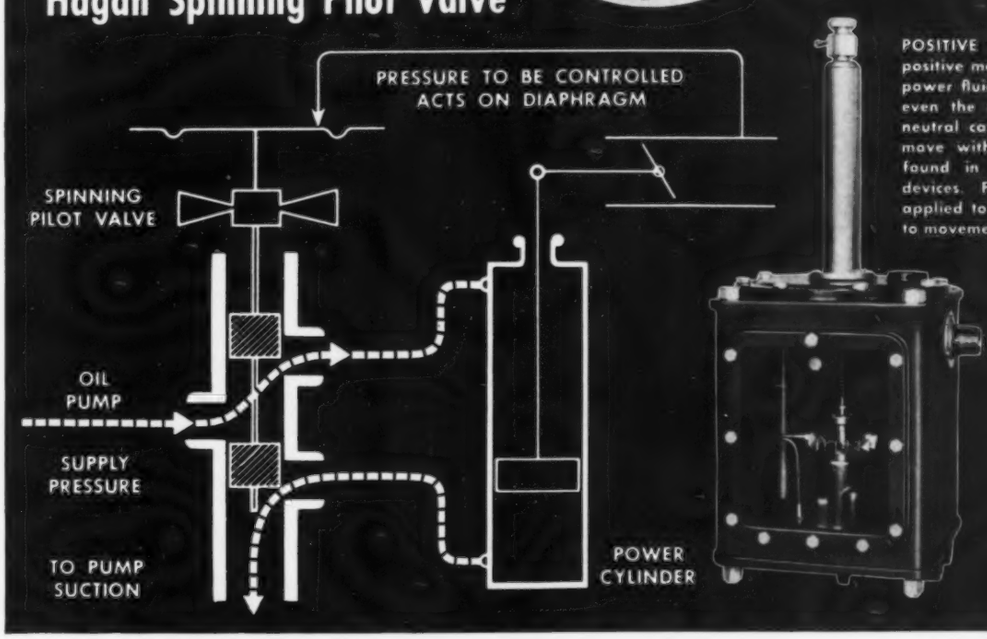
● The desirability of automatic combustion control on metallurgical furnaces is generally accepted. To gain the full benefits of automatic control, the regulator must be stable and fast enough to correct for load changes regardless of the speed with which they occur. Unless the regulator is intrinsically stable, attempts to get maximum speed cause "hunting." The *Positive Action* of the Hagan pilot valve design provides this stability and assures highest speed *without* "hunting," by preventing load fluctuations from building up to an unstable condition.



Charts taken from a Hagan gas pressure regulator working under difficult conditions of supply and demand. The necessity for speed and stability in this application is obvious.

A. Incoming gas pressure
B. Variations in flow
C. Regulated gas pressure

Hagan Spinning Pilot Valve



POSITIVE ACTION. With a direct positive mechanical passage for the power fluid from pump to cylinder, even the smallest deviations from neutral cause the Hagan piston to move with a precision not to be found in weaker forms of pilot devices. Full pressure is always applied to overcome any resistance to movement of the regulated valve.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

Exide Ironclad ease of handling means increased dependability

Complex equipment is all right in its place, but today, Industry has a big job on its hands. Tools which are simple and easy to handle, save time, money, and materials. That's why Exide Ironclad Batteries, long known for their durability and dependability, are playing such an important part in the industrial war of movement. They shorten the training periods of new workers. They save materials through their long life . . . and most of all they do a big job and do it well!

ANY WORKER CAN FOLLOW THESE EASY MAINTENANCE STEPS . . .

Keep adding approved water at regular intervals. Most local water is safe. Ask us if yours is safe.

Keep the top of the battery and battery container clean and dry at all times. This will assure maximum protection of the inner parts.

Keep the battery fully charged—but avoid excessive over-charge. A storage battery will last longer when charged at its proper voltage.

Record water additions, voltage, and gravity readings. Don't trust your memory. Write down a complete record of your battery's life history. Compare readings.

If you wish more detailed information, or have a special battery problem, don't hesitate to write to Exide. We want you to get the long life built into every Exide Battery. Ask for booklet Form 1982.

1. **High Power, More Production:** To get the most from any battery-powered electric vehicle, its battery must deliver good voltage, hold that voltage high, and be ready for emergency demands with a giant surge when needed. Exide Ironclads do just that.

2. **Long Life, Saves Materials:** Rugged Exide Ironclads are built to last, and save vital materials by getting maximum use from everything that goes into their making. When you buy an Exide you definitely—Buy to Last and Save to Win!

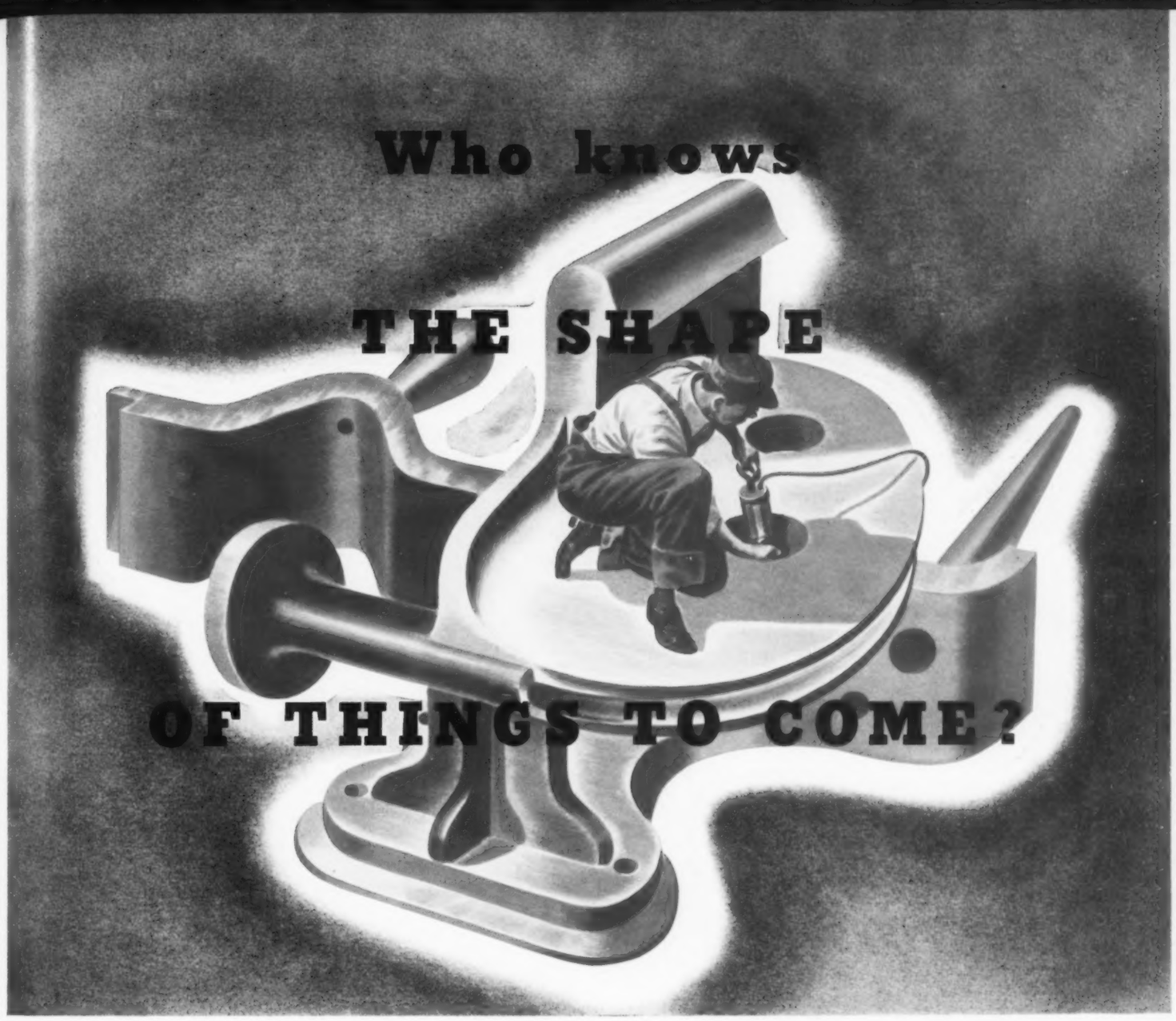
3. **Easy Maintenance Saves Labor:** Exide Ironclads are kept charged by the simplest method ever devised. With the Exide Charge Control Unit there's nothing to do but connect the battery to the charging source and turn a knob . . . a job the greenest worker can handle.

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
Exide Batteries of Canada, Limited, Toronto

ARMY E NAVY

Exide
IRONCLAD
BATTERIES

BACK THE ATTACK WITH WAR BONDS • LET'S OVER-SUBSCRIBE THE 3RD WAR LOAN



THE shape shown above, we might as well admit, has never yet been cast. It is a figment of a lively imagination.

During and after the transition from war to peace, the rewards will surely go to those who *imagine* most effectively; whose imagination, made real, will serve Industry most.

Here at Union, while the products of our furnaces and our skills are mainly concentrated on the war, we're thinking hard about what is coming after. It may well be that our postwar-pointed thinking could be of help to you—in making steel and alloy castings that better fit Tomorrow's bewildering needs.

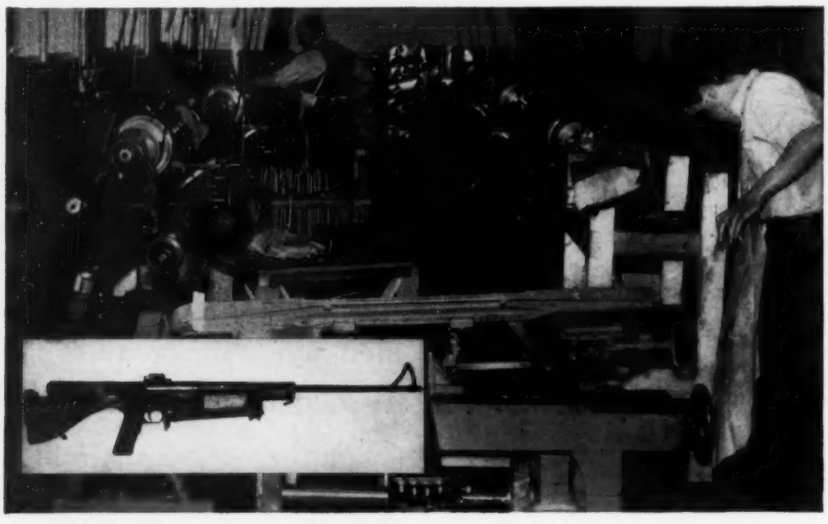
ARMY E NAVY

UNION STEEL CASTINGS Division of Blaw-Knox Company Pittsburgh, Pa.

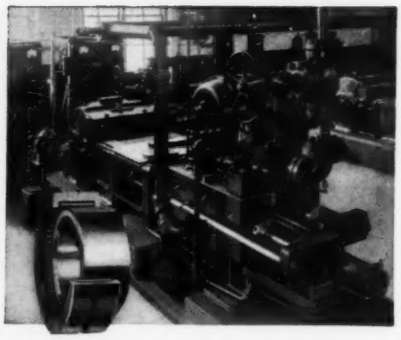
*Makers of driving wheel centers * locomotive frames * pump casings * vault doors and frames * annealing boxes * spindles * coupling boxes * open hearth charging boxes * gear blanks—and other steel and alloy castings for steel mills and general industry.*

IN THE NEWS
WITH TORRINGTON—BANTAM

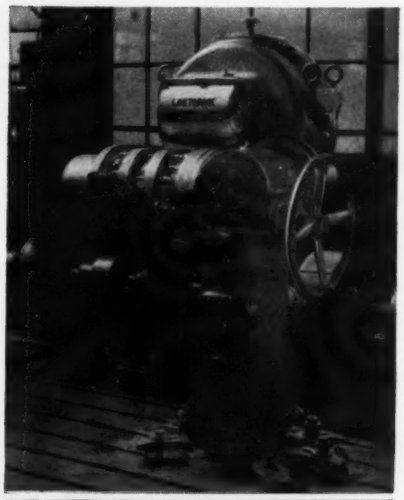
PUMPING WATER FOR IRRIGATION is just another job to the versatile Ford-Ferguson Tractor produced by Harry Ferguson, Inc. So that the fan will spin at its normal cooling rate, an "idler pulley" provides a ready adjustment for fan belt tension. Because of their high load capacity, efficient lubrication and low coefficient of friction, NCS Needle Bearings have been employed on the "idler pulley "for this frequently long-sustained job of "idler pulley" operation.

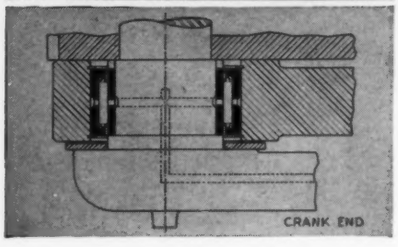


UTMOST PRECISION is required in the manufacture of .30 caliber Johnson Light Machine Guns. To produce these modern weapons of war, Johnson Automatics, Incorporated uses special precision equipment in which Needle Bearings are installed. These Needle Bearings were selected because of their unusually high unit capacity and ready adaptability to many machine tool operations.



WARTIME OUTPUT OF PLASTIC MATERIALS is aided by these large pumps built by the Worthington Pump and Machinery Corporation. Here again heavy-duty NCS Needle Bearings in the wrist pins contribute to the high operating efficiency of these pumps, which are designed for a flow of 70 GPM pumped at 2000 pounds working pressure.





HIGH LOAD CAPACITY AND SMALL SIZE, which permit the use of smaller stressed parts than would otherwise be possible, are reasons given by Philadelphia Gear Works, Inc. for the application of NCS Needle Bearings in these valve controls. Used on the crank pins, these unusual anti-friction bearings permit the use of a one-piece, rather than a split connecting rod.

A COMPLETE LINE of needle and standard anti-friction bearings—all types, for all purposes—is available from Torrington-Bantam, as well as special types and custom-designed bearings for new and unusual applications. In addition, the unbiased counsel of engineers experienced in the selection and design of bearings for every requirement is offered by Torrington-Bantam without obligation to help you meet both today's and tomorrow's needs. For assistance in the solution of *your* bearing problems, TURN TO TORRINGTON.

ARMY NAVY

TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

PRODUCTION MEN *prefer* DE LAVAL

1. De Laval Worm Gear drive gives even and constant transmission, without slipping, vibration or noise.

2. It is unaffected by grit, dust or moisture, and requires no readjustments for wear or stretch or for changes in atmospheric conditions.

3. It requires practically no attention.

4. It offers the greatest flexibility in the location of the motor and is the most compact of all drives.

5. It creates no fire or personal accident hazard.

6. It is highly efficient, improves with use, and has an almost unlimited life.

7. It is available in a wide range of horsepowers, standardized center distances and ratios.

• • •

In all principal cities there are experienced De Laval engineers who will give you immediate and competent advice in the solution of drive problems. Ask for Publication W-1131.

DE LAVAL WORM GEAR DIVISION
of the De Laval Steam Turbine Co., Trenton, N. J.

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI, OHIO

WORTHINGTON

QD QUICK DETACHABLE SHEAVES

Installing a 48" PD "C" section 8 groove QD Sheave on a 7" stroke horizontal air compressor. The QD Sheave weighs 440 pounds, four times the girl's weight.

NOW AVAILABLE for DriveN as well as DriveR applications

Women assembling GIANT DRIVEN SHEAVES, no longer are an oddity to be headlined in Ripley's "Believe It Or Not." INEXPERIENCED "GREEN" HELP in assembly plants find these sheaves simple to mount.

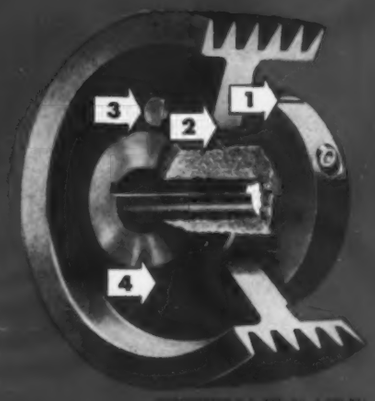
The problems of assembling and maintaining Vital DriveN and DriveR machinery have been greatly simplified with the introduction of the Worthington patented QD Sheave with its "Easy To Get On—Easy To Get Off, YET ALWAYS TIGHT ON THE SHAFT" features.

The QD Sheave design has now been incorporated into a complete range of DriveN and DriveR sizes that will accommodate 10,000 drive combinations up to 150 horsepower from stock.

One demonstration will convince you that a wrench and inexperienced hands are all that are needed to install or remove a QD Sheave, regardless of size. Arrange for your demonstration today—write or call the Worthington Multi-V-Drive dealer or the Worthington District Office in your territory.

MV3-10

Superior Advantages of the QD Sheave Design Cost No More



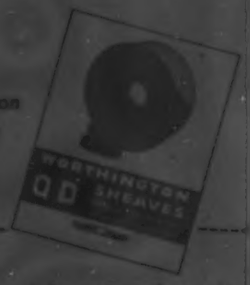
1 Split Hub for easy mounting or removal from the shaft.

2 Tapered Fit between split hub and rim for easy mounting or removal of rim from hub.

3 Pull-up Bolts which hold the rim onto tapered split hub for tapered friction drive assembly and positive press fit on the shaft.

4 Tapped holes in rim for using pull-up bolts as jack screws to free the tapered friction fit when detaching the rim.

Mail the Coupon NOW for this New Bulletin



I would like more information about the Time, Labor, and Material Saving Advantages of the Worthington QD Sheave.

Name Title

Company

Address

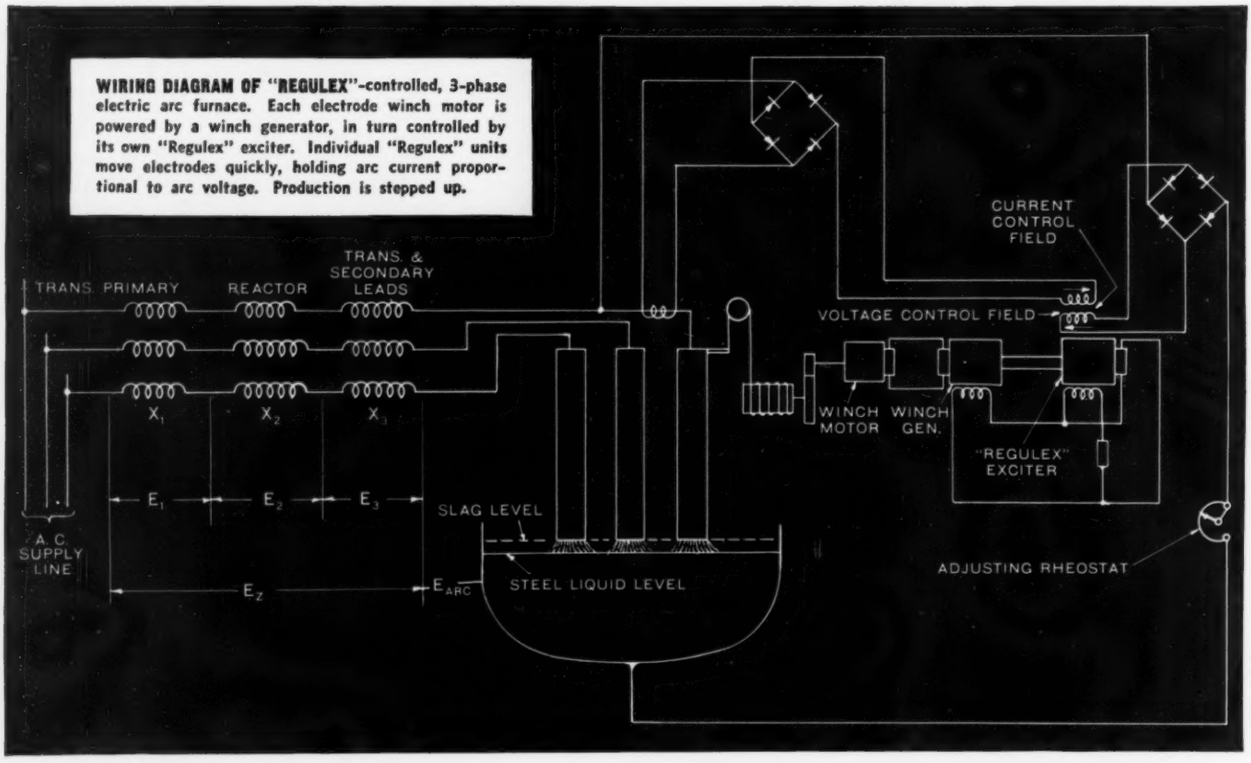
City State Country

Product Manufactured

COMPLETE DRIVES **WORTHINGTON MULTI-V-DRIVES** SHEAVES OR BELTS ONLY

WORTHINGTON PUMP & MACHINERY CORPORATION • GENERAL OFFICES: HARRISON, N. J.

INCREASE TONNAGE with revolutionary new Allis-Chalmers electric furnace control with "Regulex" exciter. ☛ Uses no contacts or motor line contactors. ☛ Produces electrode speeds proportional to deviation of controlled quantity from desired value. ☛ With no large resistance in the circuit—maximum rated speed of electrode motors is available for automatic correction after a "cave-in". Electrode burning is minimized. ☛ Heavy starting surges caused by throwing the 250 volt d-c motor across-the-line are done away with by variable voltage control. ☛ Torque is applied gradually to the electrode system, reducing effect of rope stretch. ☛ Maintenance is slashed.


WIRING DIAGRAM OF "REGULEX"-controlled, 3-phase electric arc furnace. Each electrode winch motor is powered by a winch generator, in turn controlled by its own "Regulex" exciter. Individual "Regulex" units move electrodes quickly, holding arc current proportional to arc voltage. Production is stepped up.
TRANS. PRIMARY
REACTOR
TRANS. & SECONDARY LEADS
CURRENT CONTROL FIELD
VOLTAGE CONTROL FIELD
WINCH MOTOR
WINCH GEN.
"REGULEX" EXCITER
A.C. SUPPLY LINE
SLAG LEVEL
STEEL LIQUID LEVEL
ADJUSTING RHEOSTAT

THE NEWEST thing in electric arc furnace control — Allis-Chalmers revolutionary "Regulex" exciter — is bringing increased production wherever it's installed.

In one plant this smooth, fast-acting amplifying generator actually permits one or more extra "heats" per day! This output was achieved on a furnace operating side-by-side with two identical units equipped with conventional control.

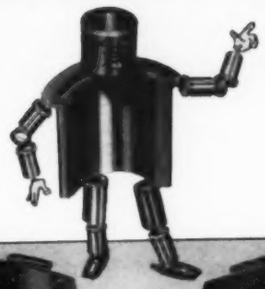
The "Regulex" exciter is an amplifying control having characteristics fully as flexible as those of the electronic amplifier — with important added advantages of the ruggedness and reliability of standard rotating electrical machinery.

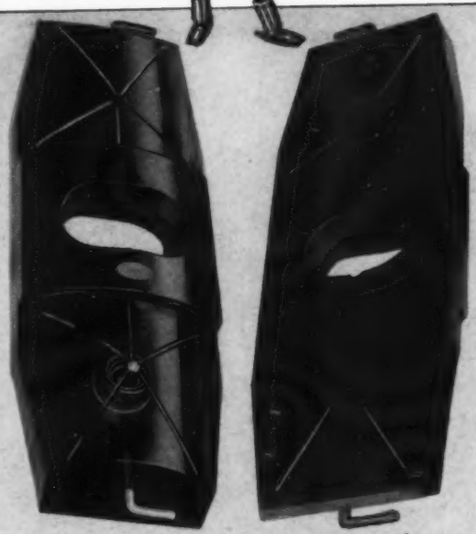
For complete information on the new "Regulex" exciter, call our district office near you . . . today. Or write direct to ALLIS-CHALMERS MANUFACTURING COMPANY, MILWAUKEE, WISCONSIN. A-1616

ALLIS-CHALMERS

WE WORK FOR VICTORY WE PLAN FOR PEACE

How GATKE BEARINGS Help SPEED STEEL PRODUCTION





Tremendous Wear Life—Reduces replacement delays and bearing maintenance 90% and more.

Accurate Holding of Gauge—Maintains close tolerances—avoids screw down delays and minimizes "off section" losses.

Eliminate Hot Necks—No waiting for necks to cool. No premature neck breakage due to heat checking.

Lowest Friction—Permits heavier reduction per pass.

Furnished Ready to Install—No machine shop work required.

Through savings of power, maintenance, and grease, GATKE Bearings *contribute mightily to the War Effort.* They are moulded to machined accuracy for replacing metal bearings quickly and at insignificant cost.

Whatever your service send specifications covering the application for Facts and Figures.

GATKE Self-Alyn Slipper Bearings typify GATKE development ingenuity, as well as the marvelous resistance to shock and wear afforded by GATKE Moulded Fabric Bearing Materials.

On Universal Couplings of all types and sizes GATKE Slippers give ten times more service than bronze. Eliminate scoring and wear to sockets and spades. Stop severe pounding, vibration and deafening noises. Facilitate proper lubrication and avoid grease slinging.

They are moulded to finished dimensions for replacing ordinary Slippers without machine shop work.

The great economies of GATKE Bearings are not limited to Roll Necks. They are giving wonderful results on Spindle Carriers, Table Rolls, Guide Rolls, Conveyors, Cranes and other troublesome applications.

Write for descriptive bulletin showing performance results on typical applications, covering a wide range of service requirements.

Other GATKE PRODUCTS

Brake Lining
Clutch Facings
Friction Blocks
Silent Gears
Pump Valves
Piston Rings
Sheet Packings

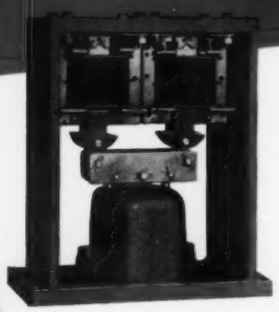
GATKE CORPORATION 228 N. LaSalle St., CHICAGO 1,

Gatke NON-METALLIC MOULDED FABRIC **Bearings**

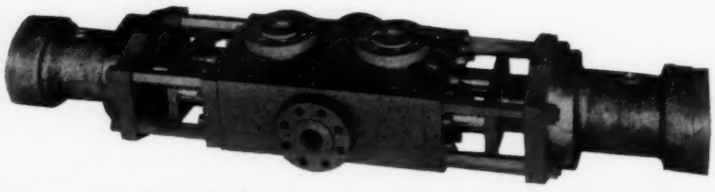
For Roll Necks, Universal Couplings, Spindle Carriers, Table Rolls, Cranes, Acid Resisting Service, and Other Tough Jobs.

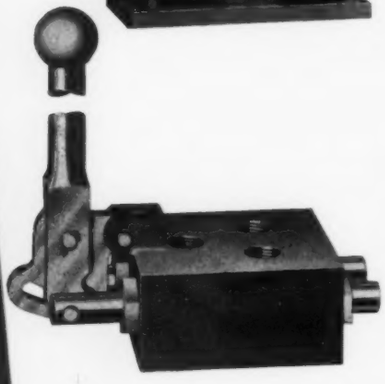
Quick-As-Wink Valves

FOR THE STEEL INDUSTRY



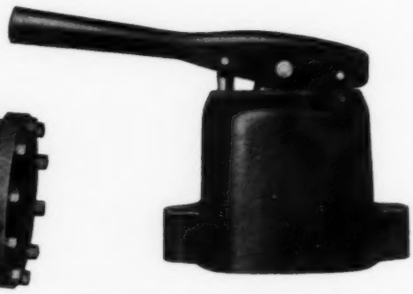
FOR COILERS: Solenoid-operated air valves function quickly and dependably for the control of gates, tilting tables, extractor cylinders on hot-strip coilers.





FOR ROLL BALANCE: Q. A. W. valves provide efficient and reliable control for hydraulic roll balance systems—lever-operated, 3-way, off-and-on exhaust action. Made for any pressure.

FOR FORGING PRESSES: Pilot-operated three- and four-way neutral action hydraulic valves for forging presses. Also used on slab pushers and manipulators.



FOR DESCALING: Designed specifically for descaling operations. A complete range of sizes from 1½ to 6 inches. Standard in the steel industry since 1935.

GENERAL PURPOSE AIR VALVES: Complete range of types and sizes of hand-operated air valves, in all popular actions for control of single and double acting air cylinders.

THE HIGHER THE PRESSURE
AIR
WATER
OIL
THE TIGHTER THE SEAL

C.B.HUNT & SON

Salem, Ohio

QUALIFIED FIELD ENGINEERS IN ALL PRINCIPAL STEEL MILL DISTRICTS

let's break it down...

We've only been knocking at that door . . . Midway . . . Guadalcanal, Attu, Buna, Munda . . . Tunisia, Pantelleria, Sicily. . . .

Magnificent actions all . . . but only steps that have brought us to the threshold of Victory.

Now it's here. *Invasion!*

But we've got to back these fighters with a fighting home front.

The 3rd War Loan Drive is on. The quota is $15,000,000,000.

The United States Government is asking you to invest in at least an *extra* $100 bond during September. But the job doesn't end there. We've got to get our family, friends and fellow employees to invest in their share of these victory-producing bonds and back the attack that has brought us this far.

Remember, this is what we've been waiting for. This is *invasion!*

back the attack with war bonds!

The Okonite Company, Passaic, N. J.

manufacturers of insulated wires and cables since 1878

WANT LONGER BEARING LIFE?

Want Less Down Time?

SIMPLIFY Load Stresses *the* ROLLWAY *Right-Angle Way*

By carrying every load—both radial and thrust—at right angles to the roller axis, Rollway's solid cylindrical roller bearings automatically split the load into the two fundamental components of *pure* radial and *pure* thrust. That reduces the load stresses per roller and per bearing. It eliminates all compound loads, and all oblique resultants. You get more accurate engineering of the bearing to the job. You get a bearing which lasts longer under heavier loads and continuous running. Downtime for maintenance and replacement is substantially reduced.

Follow this

BASIC BEARING PRINCIPLE

- **Carry all radial loads at right angles to the roller axis.**
- **Carry all thrust loads at right angles to the roller axis.**

Standard Sizes for Most Applications

Rollway has developed a large list of types of solid cylindrical roller bearings in both SAE and American Standard metric sizes, each having definite characteristics to meet exacting needs. Take full advantage of this wide choice of types and sizes. Let Rollway's specialized bearing experience help you in your choice. Just send a sketch or detailed description of your machine design or bearing problem. A confidential bearing analysis and recommendation will be returned to you without cost or obligation.

ROLLWAY BEARING COMPANY, INC., SYRACUSE, NEW YORK

BUILDING HEAVY-DUTY BEARINGS SINCE 1908 **BEARINGS**

Handy Checklist

FOR BUYERS OF STORAGE BATTERIES FOR INDUSTRIAL TRUCKS

1. Is the battery rugged enough to withstand severe physical shock and vibration?
2. Can it be shortcircuited without injury?
3. Can it be overcharged without injury?
4. Can it be over-discharged without injury?
5. Can it be accidentally reverse-charged without injury?
6. Can it take a full charge in six to seven hours?
7. Is it free from finish-rate limitations?
8. Does it withstand temperature extremes?
9. Is it immune to damage by freezing?
10. Is it free from sulphation?
11. Is it free from shedding of active material?
12. Is it free from buckling of plates?
13. Is it free from jar breakage?
14. Are its assembly and its cell connections simple?
15. Is its life longer than any other type?

★ **IF** the answer to *all* of these questions is "Yes," the battery is an Edison Alkaline Battery.

★ **IF** the answer to *any one* of these questions is "Yes," the battery is an Edison Alkaline Battery.

Edison

ALKALINE BATTERIES

EDISON STORAGE BATTERY DIVISION, THOMAS A. EDISON, INCORPORATED, WEST ORANGE, NEW JERSEY

Meet the Equipment Manufacturer

PALMER-BEE COMPANY

Herewith is presented the fifth in a series of articles outlining the history and development of the many companies servicing the iron and steel industry. It is felt the progress of the equipment manufacturer has been so closely allied with the upward march of the steel industry that our readers would be interested in the many developments sponsored by the manufacturer which were so helpful to the industry. In later issues this series will be continued.

BUD SCOTT PHOTOS

▲ The Palmer-Bee Company was founded in 1905 by Wm. E. Bee and incorporated to manufacture power transmitting and material handling equipment. R. A. Palmer whose name is still retained, was never active in the business as he entered the automobile field at the time the company was formed. Wm. E. Bee retired from active service in 1932, and his son Geo. A. Bee, who had been secretary and treasurer, succeeded him as president and general manager.

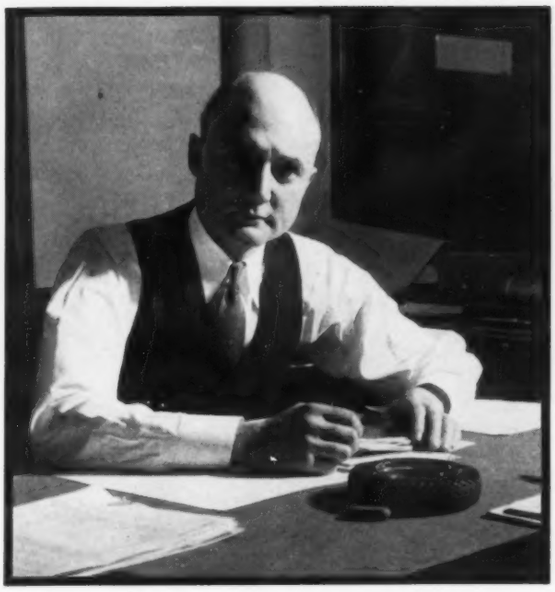
During the first ten years of its existence, the company occupied a four-story building in the downtown area of Detroit where a large stock of power transmission machinery and appurtenances was carried, and a machine shop was operated.

In 1915, to provide for a rapidly expanding conveyor business, property was acquired on West Grand Boulevard where a machine shop, structural steel shop, warehouse and office building was built. This plant, totaling 60,000 sq ft of floor space, is now operated by the Palmer-Bee Company for the manufacture of special precision equipment for the United States Signal Corps.

Within ten years additional quarters were required, and seven and one-

JESSE E. McBRIDE — vice president and chief engineer — University of Pittsburgh — came with the Palmer-Bee Company in 1911 — member of Association of Iron and Steel Engineers — believes material handling equipment for the steel mill and non-ferrous industries has a great future.

GEORGE A. BEE — president and general manager — Detroit University — worked up through the machine shop — engineering department — sales — secretary and treasurer to succeed his father, William E. Bee, in 1930 as president and general manager.



CARL F. McLAREN — in charge of cost and heavy equipment sales — Princeton, 1923 — became a director of Palmer-Bee Company in 1936 — formerly with Mathews Conveyer Company and Link-Belt Company.

JOHN H. FLETCHER — works manager — born in London, England — educated at Bloomfield Road and Woolwich Poly-technic, London — served apprenticeship in British Royal Gun Plant and as mechanic at Ford Motor Company — came up through Palmer-Bee engineering department.

JOSEPH P. BENZ — manager of Pittsburgh office — Carnegie Tech — before coming with the Palmer-Bee Company was associated in an engineering capacity with the following: Carnegie-Illinois Steel Corporation at Homestead, Heyl and Patterson, Fairmont Mining and Machinery Company, and Diamond Alkali — member of the Association of Iron and Steel Engineers.

THOMAS RAESIDE — plant superintendent — born in Glasgow, Scotland — educated at Royal Tech, Glasgow — was formerly connected with Beardmore Naval Construction Works in Scotland, and in this country with Bethlehem Steel Company, Great Lakes Steel Company and Mesta Machine Company.

half acres were purchased in a factory district where a modern manufacturing plant was built covering 182,000 sq ft of floor space. This plant is devoted to the manufacture of power conveyors, roller conveyor, speed reducers, rolling mill equipment, fabricated steel and power transmitting appliances.

A third plant is owned and operated in Winston-Salem, North Carolina, for the manufacture of light conveyor equipment including roller, trolley, belt and assembly conveyors to serve the southern and eastern territory.

While their engineers were fully experienced with the design of conveyors for handling loose materials such as coal, grain, ore, cement, etc. in bulk form, and were making many installations of this kind, the history of the Palmer-Bee Company is also the saga of material handling equipment for mass production in the field of manufactured products.

In 1910 automobile production began to expand and to continue to expand year after year until the present global war brought it to a temporary stop. During the early years of this period the Palmer-Bee Company initiated, designed, manufactured and installed practically all the mass production conveyors used in the automobile and allied industries. These basic designs are in general use today in every industry where the product is made in large quantities. They include the overhead trolley conveyor, with trolleys up to two ton capacity from which loads are suspended, installations one and one-half mile in length, operating in both vertical and horizontal planes. The carry-all conveyor, an exclusive Palmer-Bee product, is built similar to the trolley, but usually operates on the floor with the load carried on top of trucks or pallets spaced at suitable intervals.

These attainments were largely made possible by the use of precision roller bearings first introduced into the factory production conveyor design by the Palmer-Bee Company.

They also include the single and double chain conveyors for processing materials, the sub-assembly of various parts and the now well known final assembly lines.

The rubber industry kept pace with the automobile, and Palmer-Bee engineers were called upon to create suitable conveyor designs for handling rubber from the crude state through all processes of manufacture. These included tire mold conveyors that supplanted arduous manual labor operations and revolutionized the method of curing tires, as well as the free trolley system for automatic collection and distribution.

The conveyor methods and designs initiated in the automobile and rubber industries were introduced by Palmer-Bee engineers into the agricultural, furniture, refrigeration, household appliance and other industries. They also specialize in conveyor equipment of all kinds required in the steel, iroo, brass, aluminum and magnesium foundries.

The Palmer-Bee Company entered the steel mill industry as builders of auxiliary equipment in the early thirties and have made the following distinctive contributions used for the first time in this industry.

1. Hot strip coil conveyors from coilers to storage with heavy duty roller bearing rollers integral with the conveyor chain.

2. Smooth operating right angle hot coil transfer.

3. Timken equipped roll tables and gravity rolls up to 20,000 lb capacity per roll.

4. Shock absorbing spring roll tables.

5. Double geared up-enders and down-enders with Timken equipped rolls.

6. Retractable down-enders and loaders from coiler to hot coil conveyor.

7. Sheet and plate end pilers with Hyatt roller chain run-out tables.

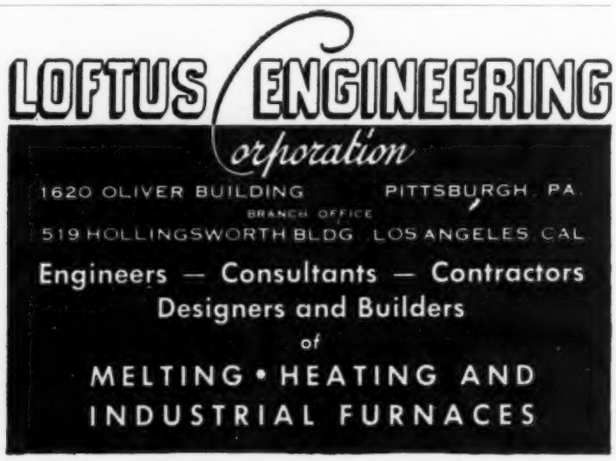
8. Self-aligning cast steel pillow blocks equipped with Hyatt and Timken bearings.

Other auxiliary steel mill equipment which has been designed and manufactured by the Palmer-Bee Company are as follows:

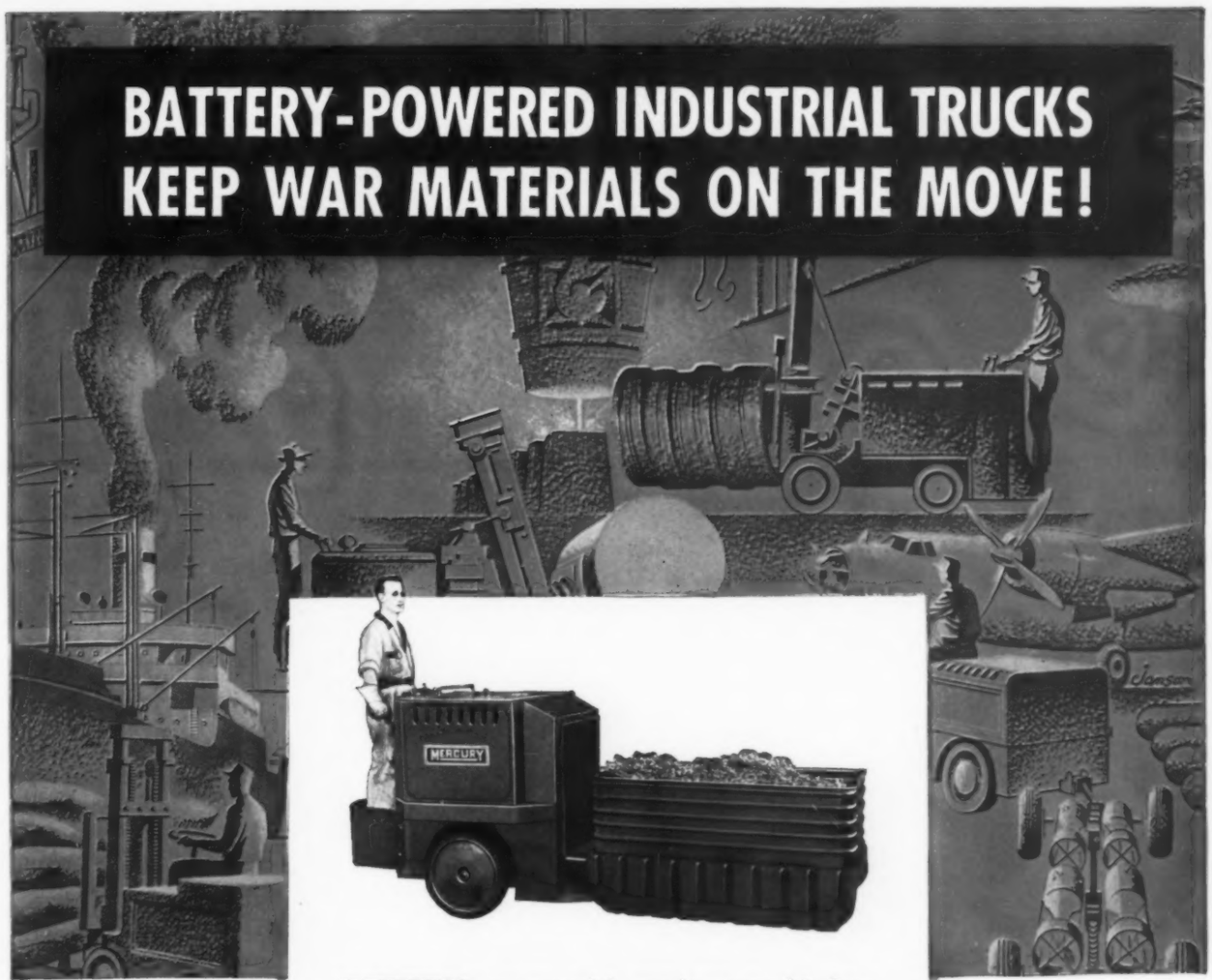
1. Plate run-out and run-in roll tables.
2. Plate transfers, both sliding and chain carried types.
3. Shear approach roll tables.
4. Shear gauge roll tables.
5. Kick-off roll tables.
6. Stacking beds.
7. Plate unpilers.
8. Transfer cars up to 200 ton capacity.
9. Plate scrap conveyor.
10. Turntables.
11. Oiling machines.
12. Soaking pit cover cranes.

The growth of the Palmer-Bee Company over a period of thirty-eight years can be largely attributed to a sound engineering policy and the development of new ideas to suit new production demands in each industry. Their effort is now one hundred per cent to help win the war. Their ambition is to do their share in post-war rehabilitation.

n·B·M BRONZE AND COPPER CASTINGS
Blast Furnace Copper Castings • Roll Neck Bearings • Housing Nuts • Machinery Castings • Acid Resisting Castings • Phosphorized Copper • Locomotive and Car Journal Bearings • Babbitt Metals
NBM
NATIONAL BEARING METALS CORP.
ST. LOUIS • PITTSBURGH • NEW YORK



BATTERY-POWERED INDUSTRIAL TRUCKS KEEP WAR MATERIALS ON THE MOVE!



KEEPING war materials moving smoothly from receiving platform to shipping department is a man-sized job . . . a job electric industrial trucks are doing *sensationally well* in thousands of plants from coast to coast.

To meet today's triple-shift schedules, more and more truck owners are replacing with Philco "XL" Batteries because Philco-Powered Trucks move *10% more material per charge!* Every cell is engineered for 10% extra capacity!

And with sustained high voltage, hour after hour, a Philco packs the extra wallop you need to get materials moved in a hurry!

Get the facts on Philco when you specify batteries for new equipment or replacements.

Typical Philco Industrial Truck Battery in Steel Tray

Write for your copy of the latest catalog on Philco Electric Industrial Truck Batteries.

ARMY E NAVY

PHILCO CORPORATION

STORAGE BATTERY DIVISION • TRENTON 7, NEW JERSEY

Sales Agents in 109 Industrial Cities

Replace with **PHILCO** *Industrial Batteries*

NEW WESTERN PLANT NEARING COMPLETION

▲ United States Steel Corporation announces the completion of arrangements with Defense Plant Corporation, a RFC subsidiary, for the operation during the war of the new Government owned steel mill in Utah, substantial completion of which is now scheduled for the end of this year. Under the terms of the agreement, these facilities will be operated for the account of Defense Plant Corporation by Geneva Steel Company, a newly organized United States Steel subsidiary.

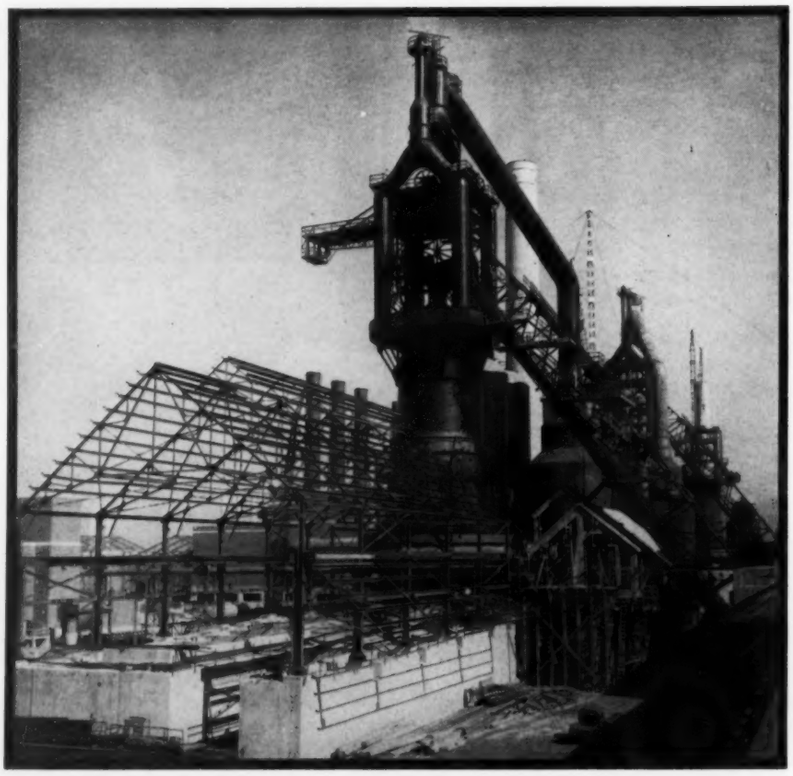
No operating fee or other compensation is to be paid to Geneva Steel Company or U. S. Steel for their services in directing the wartime operation of this large plant. All costs incidental to its management and operation will be paid by Defense Plant Corporation, and all proceeds from the sale of its products will be for account of Defense Plant Corporation.

When completed, this will be by far the largest integrated steel mill west of the Mississippi, a plant of the most modern design, whose cost will approximate $180,000,000. The site of the main plant at Geneva, Utah, known as the Geneva Works, embraces more than 1,600 acres.

These Utah facilities were ordered by the Government primarily to provide steel for war shipbuilding needs on the Pacific Coast. Geneva Works was designed by U. S. Steel engineers and is being erected for Defense Plant Corporation by Columbia Steel Company, U. S. Steel's Pacific Coast steel producing subsidiary. U. S. Steel has made available to the Government, without charge, its vast experience and knowledge in the engineering and construction of steel mills of this character. No construction fee is paid to U. S. Steel or to any of its subsidiaries for designing and directing the construction of Geneva Works. It only receives reimbursement for its out-of-pocket expense. The greater part of the construction work is being performed under subcontract with outside contractors numbering more than 100. The only subsidiary of U. S. Steel directly performing construction work is American Bridge Company, which has taken subcontracts for fabricating steel and erecting certain steel structures.

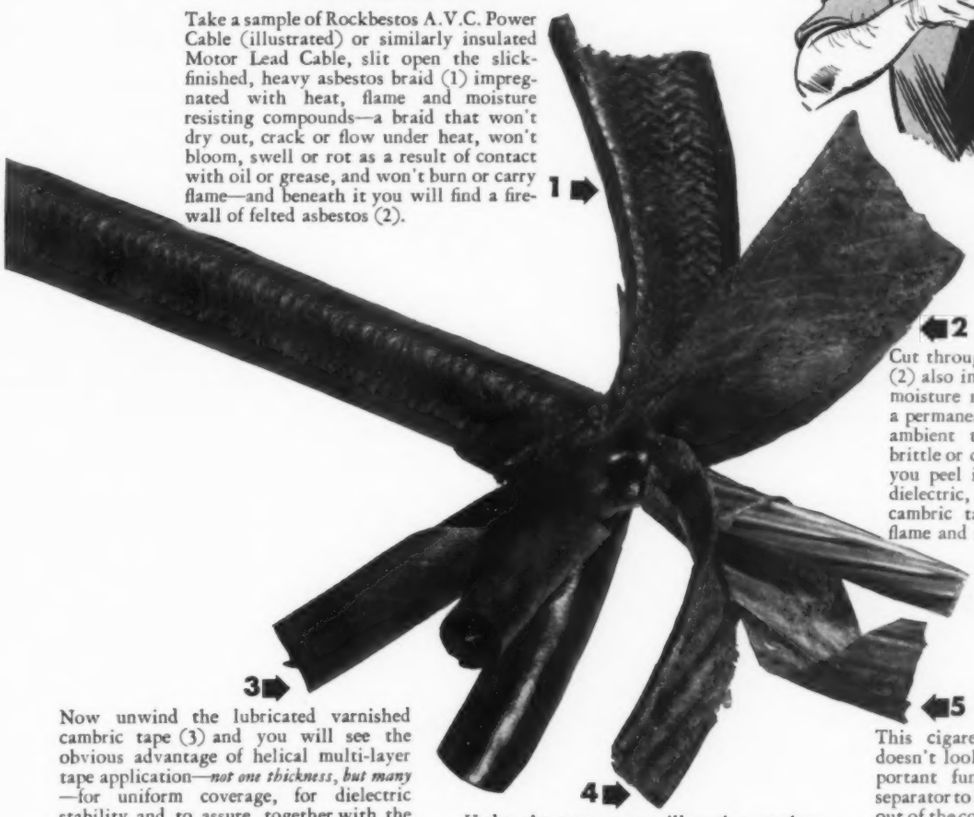
Delays in obtaining priorities of

Despite delays in obtaining priorities sufficiently high to secure essential items of equipment, construction of the Geneva plant has gradually proceeded to a point of near completion.



GET THE INSIDE STORY... APPLY THE KNIFE-TEST TO ROCKBESTOS A.V.C.

Take a sample of Rockbestos A.V.C. Power Cable (illustrated) or similarly insulated Motor Lead Cable, slit open the slick-finished, heavy asbestos braid (1) impregnated with heat, flame and moisture resisting compounds—a braid that won't dry out, crack or flow under heat, won't bloom, swell or rot as a result of contact with oil or grease, and won't burn or carry flame—and beneath it you will find a fire-wall of felted asbestos (2).



1 Cut through this felted asbestos firewall (2) also impregnated with heat, flame and moisture resisting compounds to provide a permanent protecting wall against high ambient temperatures that won't bake brittle or crack with vibration, and when you peel it back you will see the high-dielectric, moisture-resistant varnished cambric tape (3) it protects from heat, flame and oxidation.

2 Now unwind the lubricated varnished cambric tape (3) and you will see the obvious advantage of helical multi-layer tape application—*not one thickness, but many*—for uniform coverage, for dielectric stability and to assure, together with the helically applied felted asbestos, perfect and permanent centering of the conductor in the insulation.

3 Under the tapes you will notice another felted asbestos firewall (4). An inner heat-barrier to complete the protection of the varnished cambric, put there to prevent the heat of overloads from attacking the tapes. It won't ignite or burn even when exposed to copper-melting arcs. Now slit this felted wall and peel it back, and you'll see beneath a thin layer of paper (5) over the conductor.

4 This cigarette-thin layer of paper (5) doesn't look like much but it has an important function. It is employed as a separator to keep insulation and compounds out of the conductor so that it will be clean and strip easily. And that completes the story of the construction of Rockbestos A.V.C. *the wire with permanent insulation.*

5

Try the simple test outlined above on a sample of Rockbestos A.V.C. wire or cable of your selection, which we will send on request, and you'll readily see why *permanently insulated* Rockbestos resists heat, flame, moisture, corrosive fumes, oil and grease—and gives long-lived service under high operating temperatures and severe conditions.

Rockbestos A.V.C. Power and Motor Lead Cables and Lighting Wire (Underwriters' and National Electrical Code, Type AVA) have a maximum operating temperature rating of 110° C. (230° F.), and will not bake brittle, crack, bloom, swell or rot. Send for a sample and make your own jack-knife test. Write to us at New Haven or the nearest branch office:

ROCKBESTOS PRODUCTS CORPORATION
909 Nicoll Street, New Haven 4, Connecticut

ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

FOR VICTORY ★ Invest in United States War Bonds ★

NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.

NEW
BAKER HY-LIFT TRUCKS
DESIGNED TO MEET MODERN REQUIREMENTS

NOTE:
Baker has re-designed many of its trucks to meet Industry's needs for increased production:

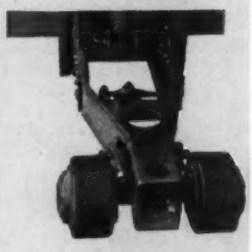
1. Longer continuous operation
2. Faster handling of material
3. Lower maintenance

FOR INCREASED PRODUCTION AND EFFICIENCY

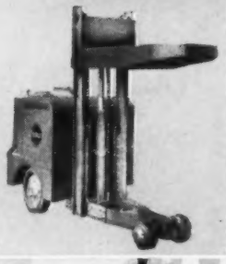
Larger battery box (32" x 39½") permits enough battery capacity to operate trucks continuously on longer shifts. Streamlined design of battery compartment with chamfered front top corner, provides greater visibility for the driver. Sliding type battery cover is equipped with handles for faster servicing.

Controller, contactors, lift motor and pump are grouped together in a conveniently accessible control panel. Travel brake, just below, is easily adjusted by a single hex nut. Operator's guard built integral with frame for greater strength and improved appearance, provides handy compartment for carrying towing chain, pinch bar, or other tools.

Easy steering results from proper design and antifriction bearings on king pins. All steering levers and rods are inside frame, protected against damage. Frame members are fabricated of heavy plate by hot riveting and arc welding.



Efficient, trouble free hydraulic lift provides power lifting and gravity lowering, under operator's absolute control at all times. 67" single lift for two or three high tiering is standard.



The same advantages which have been designed into these trucks to speed the production of war goods also apply to normal peacetime material handling. The model illustrated, designated as Type H-3, is of 6,000 lb. capacity.

Improvements include a new hydraulic lift system which provides efficient, positive control of hoisting and lowering, increased battery compartment permitting longer continuous operation, operator's guard integral with frame for greater strength and safety, and other features which provide increased efficiency and easier maintenance . . . The new improved design is also available in 4,000 lb. capacity. (Type H-2.)

Write for complete information

BAKER INDUSTRIAL TRUCK DIVISION
of the Baker-Raulang Company
2166 WEST 25th STREET • CLEVELAND, OHIO
In Canada: Railway and Power Engineering Corporation, Limited

1211-1-43

sufficiently high rank to secure hoped-for early deliveries of essential items of equipment have retarded completion of Geneva Works and also greatly increased the original estimated cost. Another hindering factor has been a shortage of labor. Despite these obstacles, this large integrated plant, embracing raw material facilities, coke ovens, blast furnaces and steel-making and finishing equipment, having an annual capacity of approximately 1,200,000 tons of ingots, 700,000 tons of plates and 250,000 tons of structural steel, is nearing completion. This huge plant was created from scratch in the midst of what was an agricultural district less than two years ago.

HYDRAULIC PRESS FOR SHOP WORK

▲ The R. D. Wood Company, Philadelphia 5, Pennsylvania, has designed and built a self-contained hydraulic wheel press with unique pneumatic pullback. The press is for use in railroad repair shops, machine shops, and general industrial work.

There are openings of 10 inch radius provided both in the resistance post and the end post to accommodate the work. The resistance post operates on bearing equipped rollers, on the machined face of the base plate, for easy movement in either direction. Where the use of a stop plate is necessary, a recess having an 11 inch radius has been provided in the resistance post, in which the plate is inserted.

The pump is of the vertical, triplex, two-pressure type, having two high pressure and one low pressure plungers, actuated by three eccentrics. The ram travel is 26 inches. Its approach speed is 70 inches per minute. Ram speed at low pressure, 10 inches per minute; at high pressure, 3¼ inches per minute. Return speed 40 inches per minute. Maximum capacity at high pressure 600 tons, at low pressure, 100 tons.

The press can be installed flush with the floor. Wood has incorporated a pneumatic pullback device which not only does away with the necessity of providing a pit to accommodate counter-weights, but which gives a faster rate of ram return than the customary ballast weight.

STEAM AND DIESEL LOCOMOTIVES FOR C-I

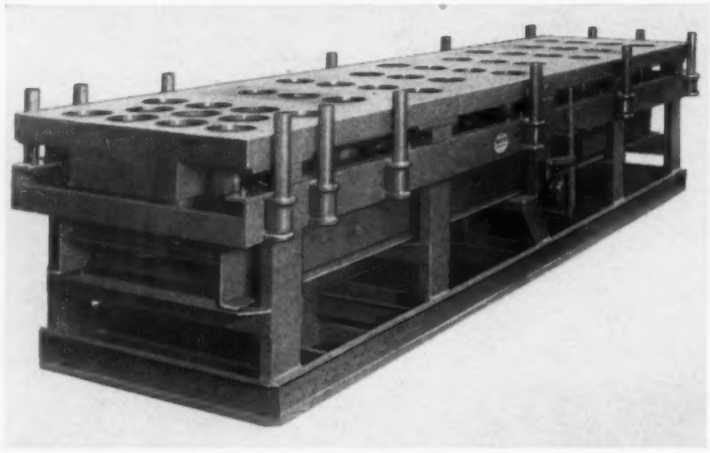
▲ Twenty-three locomotives are now being manufactured by H. K. Porter Company, Inc., for Carnegie-Illinois Steel Corporation, 12 of them to meet the pressing demand for more locomotive power at the Homestead, Pennsylvania, Works.

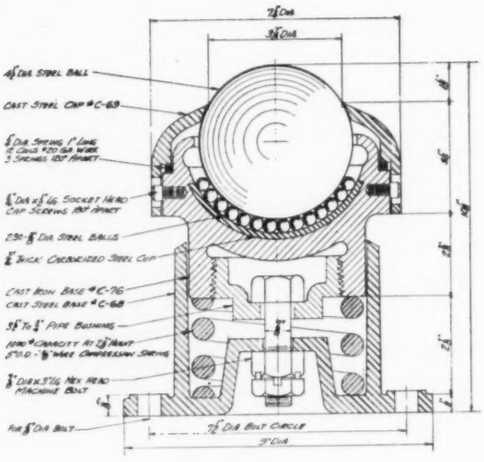
Six diesel electrics and six steam locomotives, in the 60 and 35 ton classes, are included in the group being made for Homestead, according to a company announcement. They will be employed in hauling scrap to charge the open hearths, and transporting ingots from the open hearths to rolling mills and preheating furnaces.

The diesels will represent the first employed at Homestead, where they are particularly desired to eliminate smoke and steam inside the buildings.

A Real Aid to
PRODUCTION
HAYS
OPEN HEARTH
PRESSURE CONTROL
TONNAGE can be increased through more even operation and even operation also means fuel saving. Automatic control of furnace pressure, rates of fuel and air flow, ratio of fuel to air, constant volume or pressure of oil or gas relieves the operators of many time-consuming details, allowing them to pay more attention to the steel making process.
When desired, the control of these various functions can be handled manually from a centralized panel through remote operation. Hays control is all-electric, simple to install, simple to operate, simple to understand.
The following Hays instruments may be used effectively in combination or separately for the functions indicated.
Type CDE-X Furnace Pressure Controller with external manual adjustment for automatically operating stack damper to hold pressure constant.
Series FOT Pressure Indicator provides an easily read measurement of furnace pressure. Usually connected at furnace roof.
Series OT Pressure Recorder provides daily record (24 hr. chart) of furnace pressure. Shows timing of reversals and each change of pressure made by operator during the heat.
Hays partial or complete instrumentation is a REAL AID TO PRODUCTION. Hays representatives located in the principal cities of the U.S.A. and Canada will gladly supply complete information.
TYPE CDE-X FURNACE PRESSURE CONTROLLER
SERIES FOT PRESSURE INDICATOR
SERIES OT PRESSURE RECORDER
HAYS
OUTLET DAMPER
The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

BALL TRANSFER TABLES FOR HANDLING ARMOR PLATE





Twenty-four of these tables 19 ft long x 4 ft wide were recently furnished a midwest armor plate plant. The tables incorporate Type 1020 spring-mounted ball transfers with 1,000 lb capacity per unit. The surface plates were machined to a maximum flatness deviation of .015 when supported on machined pads. The elevation of the ball transfers in the "up" position is 3 ft 8 in. and in the "down" position 3 ft 5½ in. The units are operated pneumatically, actuated by a 10 in. diameter, 8½ in. stroke cylinder.

The tables are for handling armor plate up to 3 in. thick and a maximum weight of 10,000 lb. The plates move onto the tables over the ball transfers in the "up" position. The transfers are then lowered and the plates allowed to rest on the level surface plate of the table. The inspectors can then readily test the plates for straightness and flatness.

When the straightness test is completed, the operator again raises the transfers and the plate is moved off the table either to be returned to the straightening presses or to continue for further processing.

These tables are a development of the Mathews Conveyer Company, Ellwood City, Pennsylvania.

WEST COAST STEEL PLANT STARTS PLATE ROLLING

▲ Pittsburgh, the mother of mills, built the great plate mill for Henry Kaiser's Fontana, California, steel plant, where for the first time a west coast mill is rolling steel plate from steel produced with western iron ore.

Lewis Foundry and Machine Division of Pittsburgh's Blaw-Knox Company completed Kaiser's hurry-up order in the record time of 15 months. The 110-inch Lewis tandem is the first of Kaiser's three great mills to go into operation, producing steel plate for construction of Liberty ships in the Kaiser Company's west coast shipyards.

On hand for the opening ceremonies last week were W. C. Snyder, Jr., president of Lewis Foundry and Machine (left), and George Havas, chief engineer of Kaiser Company, Inc. The Lewis order for the Kaiser enterprise consisted of a single-stand 2-high reversing mill for breaking down ingots direct and a 3-high single-stand finishing mill with auxiliary equipment including levelers, shears, tables and pilers.

NEW FOUNDRY COMPLETED

▲ One of the largest and most modern foundries in the United States, comprising 43 acres, built by the Defense Plant Division of Columbia Steel Company, a U. S. Steel subsidiary, near Pittsburg, California, has been completed and is now in operation, Columbia Steel Company officials announced recently.

The new project, which is located on property adjacent to Columbia Steel Company's Pittsburg Works, was constructed at a cost of more than $6,000,000 at the expense and for the account of Defense Plant Corporation. The government has contracted Columbia Steel Company to operate the new foundry for the duration of the war.

When running at full capacity, the new foundry will provide approximately 30,000 tons of steel castings annually. However, a shortage of skilled manpower and the delayed delivery of several installations will retard the foundry getting into full production for several weeks.

Products of the plant will be used primarily by the United States Navy and Maritime Commission. Facilities of the new plant include two twenty-five ton basic open hearth furnaces. A six-ton electric furnace is expected to be delivered for installation in a few weeks.

A "U" shaped structure, equipped with the latest of machinery, the new foundry is so constructed to provide a smooth flow of products. A cleaning bay is located on each side of the "U." One cleaning room is used for smaller materials, while the other bay is used for finishing major castings. The finished products can be moved easily by cranes onto either railroad car or truck. Eighteen electric cranes service the foundry, including two 50-ton, two 40-ton and two 30-ton cranes.

EQUIPMENT MAKER EXPANDS PLANT CAPACITY

▲ Improvements totaling approximately $200,000 will be completed at the Thomas Machine Manufacturing Company, Pittsburgh, Pennsylvania, by the end of September, George P. Thomas, president, said recently. Privately financed, the work includes installation of additional machine tools and of handling facilities, and additions to buildings, increasing the company's capacity.

★ Schloemann "Motor-Rollers" are instrumental in increasing plant efficiency due to their simple design and rugged construction.

The squirrel cage motor, contained within the roller, and with no electrical connection to the rotor, represents the simplest piece of apparatus for converting electrical energy into mechanical work.

Mechanical design of the "Motor-Roller" with anti-friction bearings and a minimum number of rotating parts reduces operating and maintenance costs and avoids delays.

Scale tables, such as those illustrated above, provide flexible operation under start-stop-reversing service and possess the advantage of free access along both sides of the tables.

SCHLOEMANN
ENGINEERING CORPORATION
1102 EMPIRE BUILDING . . . . . PITTSBURGH, PA.
HYDRAULIC PRESSES • ROLLING MILL MACHINERY

NEW HOLDER FOR MANUAL MARKING

▲ An improved design safety box type holder, for marking purposes, is being marketed by the M. E. Cunningham Company. The marking device is said to be universally applicable to operations previously using hand or sledge holders. The holder can be designed for marking round or square pieces either hot or cold. A reinforced outer box, to which a handle is welded, levels the holder on the piece being marked and acts as a safety guard by preventing pieces of scale or chips from flying out from under holder. The reinforced box is a marked improvement over the old style box, and has proven to increase the service of the tool from 15 to 25 per cent.

The steel type holder rides freely inside of the box, but cannot fall out because of special shepherd hook pin which holds it in place. The holder is reported to be constructed of one-piece safety steel to resist spalling and mushrooming, and can be made in numerous sizes and number of characters.

Complete details on this new device may be secured through this publication, or by writing directly to the M. E. Cunningham Company, 115 East Carson Street, Pittsburgh (19), Pennsylvania.

FINE RECORD AT INLAND FURNACES

▲ The Inland Steel Company announced that five blast furnaces at Indiana Harbor have maintained uninterrupted production for more than three years in what is believed to be a group continuous operational record.

The five furnaces have been operating at maximum capacity since August 6, 1940 when No. 2 furnace was blown in, each producing about 1,000 tons of much needed iron daily for the war program. Company planning had taken into account the fact that this continuous push for production exacts a toll from the furnaces which might necessitate at any time shutting down one or more of them for relining or rebuilding.

This anticipatory policy resulted in the building of the sixth blast furnace which was blown in on November 16 of last year. Privately financed and with a capacity of 1,200 tons of iron per day, the new furnace was built to insure against loss in production.

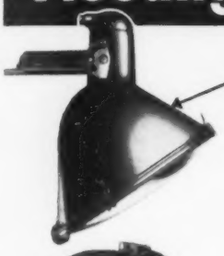
The company not only has the No. 6 furnace in steady operation but is benefiting from the fact that the other five continue to function at maximum production levels.

C-I SETS RECORD INGOT PRODUCTION

▲ Steelmakers of Carnegie-Illinois Steel Corporation, U. S. Steel subsidiary, shattered all past records for production last month, making home front news while the mounting tempo of the Southern European invasion drove home to all Americans the need for more steel for armaments.

Indication that the Allied forces were getting set to strike stiffer blows against the Axis across the Atlantic was seen in the War Production Board's action early in July, asking the steel industry to turn out two

CROUSE-HINDS
offers
IMMEDIATE DELIVERY
on
Floodlights and Searchlights



Type MUA, Light Duty Floodlights

● Easy to service. ● Weatherproof. ● Cast Feraloy socket housing, (semi-steel). ● Reflector. Porcelain enameled steel. ● Lens. Clear or stippled heat-resisting glass. ● 750, 1000 or 1500-watt lamps. ● Degree markings for accurate horizontal and vertical setting of floodlights. ● 4 Mountings. Cross arm bracket, pipe slip filter, wood pole or wall bracket, and vertical or horizontal U-bolt pipe clamp.

Type MUA can be furnished as an open floodlight. The weatherproof door can be added at any time.

Other light duty floodlights that can be shipped promptly are Type MUB in the 200, 500 and 1000-watt sizes; Type MUA Ellipsalux and Type MUA Multalux. MUA floodlights can be furnished with an auxiliary reflector that concentrates part of the light into a narrow beam for longer range.

Type ADE-14 Heavy Duty Floodlights

● A high efficiency unit. Medium and long range. ● Weatherproof sheet steel housing. ● 14-inch crystal mirrored-glass reflector, narrow or wide beam. ● Lens. Clear heat-resisting glass. 50° spread, 100° spread or diffusing lens. ● 500-watt lamp. ● 4 Bases. Standard, pipe slip fitter, single bolt, and U-bolt pipe clamp.

Prompt shipment can also be made on other sizes of heavy duty floodlights; Types ADE-12, ADE-16, LCE-1120, LCE-24, ADR-12 and ADR-14 portable floodlights; RCD-8 special vaportight and RCDE-8 special explosion-proof floodlights.

Type DCX-18 Searchlights

● Long range. ● Pedestal mounting with ball bearings and pilot house lever control. ● Weatherproof steel housing, reinforced at load points by Feraloy castings. ● Accurate silvered-glass reflector. ● Lens. One-piece, heat and impact-resisting plate glass. ● 420 to 2000-watt lamps.

Type DCE-18 searchlights with fixed mounting base and Type DCY-18 with ball-bearing pedestal base for hand directing are also available. Crouse-Hinds complete line of searchlights includes 8, 12, 18 and 24-inch sizes.

Crouse-Hinds is prepared to build special lighting equipment for war applications.

A Nationwide Distribution Through Electrical Wholesalers

CROUSE-HINDS COMPANY
SYRACUSE, N. Y., U.S.A.

Offices: Birmingham – Boston – Chicago – Cincinnati – Cleveland – Dallas – Denver – Detroit – Houston – Indianapolis – Kansas City – Los Angeles – Milwaukee – Minneapolis – New York – Philadelphia – Pittsburgh – San Francisco – Seattle – St. Louis – Washington
Resident Product Engineers: Albany – Atlanta – Charlotte – New Orleans
CROUSE-HINDS COMPANY OF CANADA, LTD., Main Office and Plant: TORONTO, ONT.

million extra tons of fighting steel for the big offensive.

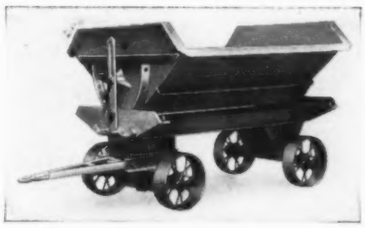
Here's how the working men and women of Carnegie-Illinois responded during the hot days of August, always a tough month for steelmaking:

The company's furnaces achieved an all-time high output for one month, producing 1,962,631 tons of ingots. That's 19,000 tons better than the best previous record. The extra tonnage alone is enough steel to produce the hull plates for four Victory cargo ships, the vessels that carry armaments to the places where they will do the most good.

The company's best previous record for one month's production was established in March, 1943.

DUMP TRAILER HAS WIDE ACCEPTANCE

▲ An "effortless swing" dump trailer, one of the many successful industrial haulage equipment designs manufactured by the Phillips Mine and Mill Supply Company, has received wide acceptance among industrial users.



The Phillips dump trailer readily swngs right or left in perfect balance, and, after dumping the body rights itself and locks in normal position. Body cradle angle permits load to slide out quickly and cleanly. The unit is equipped with Timken roller bearings, one and one-half cubic yard capacity, and may be coupled and pulled in trains.

Complete details may be secured by writing this publication, or direct to Phillips Mine and Mill Supply Company, 2217 Jane Street, Pittsburgh 3, Pennsylvania.

STEEL PRODUCTION SCHEDULES FOLLOWING BEST INTEREST OF WAR PROGRAM, SAYS BATCHELLER

▲ Surplus steel ingot capacity arising from the completion of new open hearths prior to the completion of rolling mills has been utilized in the best interests of the war program, operations vice chairman H. G. Batcheller said recently in a telegram to Eugene Maurice of the United Steelworkers of America CIO.

Mr. Batcheller's telegram was in response to a complaint by Mr. Maurice that Bethlehem Steel Company was avoiding the processing of surplus ingots produced by another company because of the freight charges involved.

Following conferences with WPB officials, Mr. Maurice has agreed that the best possible use of steel melting capacity has been made by the War

TATE-JONES Furnaces
for BOMB QUENCHING
One of a sequence of furnaces used in the manufacture of BOMBS. Beside this we build plate heaters, reheaters, nosing, draw furnaces, conveyor systems.
TATE-JONES
TATE-JONES & CO., Inc.
LEETSDALE, PA.
Rotating Hearth, Car Bottom, Pusher, Conveyor, Roll Down, Horizontal and Vertical Pit, Circular and Rectangular Pot Furnaces
Also Gas, Oil and Combination Burners

Production Board, Mr. Batcheller said. Mr. Maurice also expressed his approval of plans formulated by the Steel Division of WPB to direct movement of any surplus ingots that may become available in the future from the producing mill to the Bethlehem Company's Johnstown mill and other finishing mills where they may be finished into end products most needed in the war effort.

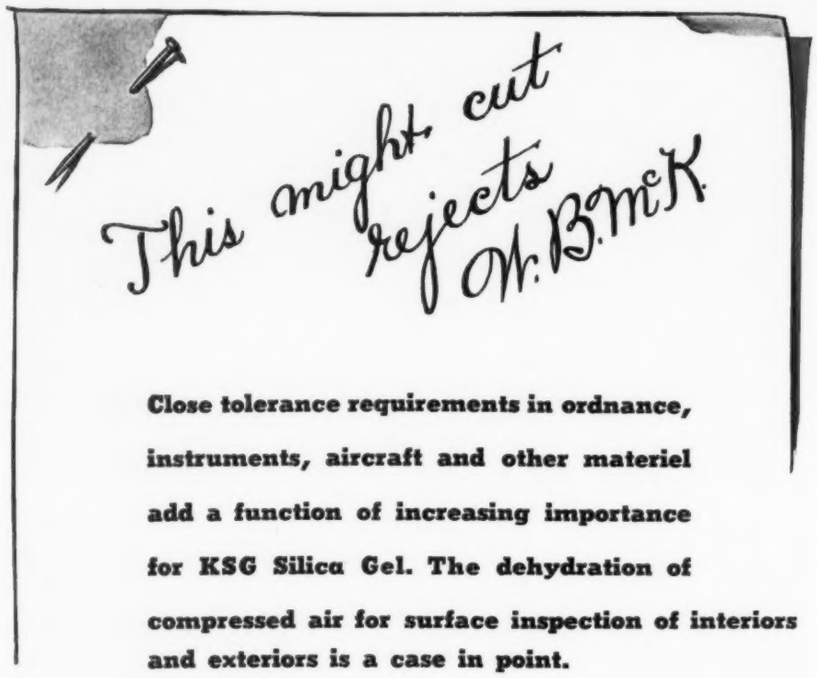
Text of Mr. Batcheller's telegram: Mr. Nelson has instructed me to investigate the possible increase in supply of steel vitally needed for the war program through the rolling of ingots which can be produced by Carnegie in excess of their finishing capacity by Bethlehem at the Johnstown plant where surplus finishing capacity exists, and your complaint that Bethlehem is avoiding the processing of such surplus ingots because of freight charges involved, all as referred to in your telegram of August 9.

You state that such ingots are available at the Homestead plant of Carnegie. This is not the case. Investigation shows that wherever surplus ingot capacity has existed, such as at Kaiser plant in California and Carnegie Mill at Homestead, where new open hearths have been completed prior to completion of rolling mill facilities in some plants, such ingots have been utilized in best interests of the war program. Kaiser ingots have been supplied to meet vital requirements of our Allies under Lend-Lease. Ingots produced by Carnegie on new open hearths already completed have been fully utilized by other mills of the U. S. Steel Corporation or by other steel companies.

The War Production Board has tried and we believe has succeeded in providing that every available ton of melting capacity which could be used has melted steel for the war effort.

It is possible that as additional open hearths come into completion ahead of new mills more ingots may be temporarily produced than can be absorbed by all present arrangements. Our Steel Division, anticipating this, is actively engaged in planning for best possible use of such production in the best interests of the war program and on the most equitable possible basis to all concerned. You may rest assured that every ton of ingots which can be produced now or in the future will be utilized as it has been in the past.

You can readily realize that on an industry-wide basis this is a complicated situation. If you have any further anxiety concerning possible loss of steel in the war effort we shall be glad to have you come to Washington to discuss it further with us and to give us the benefit of any constructive suggestions you have to offer.



Close tolerance requirements in ordnance, instruments, aircraft and other materiel add a function of increasing importance for KSG Silica Gel. The dehydration of compressed air for surface inspection of interiors and exteriors is a case in point.

Available in a wide range of capacities, starting at 20 cfm and built for continuous or intermittent operation as may be required, KSG Silica Gel Dryers meet every industrial drying need.

For descriptive bulletins, specific information or engineering assistance, address The C. M. Kemp Mfg. Company, 405 E. Oliver St., Baltimore-2, Md.

KEMP of BALTIMORE

NEW ELECTRIC FURNACE NOW IN OPERATION

▲ A new 40-ton electric furnace kicked into operation at the Ambridge plant of A. M. Byers Company recently. Approximately 85 per cent of steel production will go into materials for the army, the balance into alloy steel tubing.

The new furnace, the Heroult type, has a very deep hearth and other improvements that reflect the company's previous experience with electric steel equipment. It delivers a 40-ton heat every six or seven hours.

REPUBLIC BREAKS GOVERNOR DEWEY INTO THE STEEL BUSINESS

New York's Governor Thomas E. Dewey saw his first steel mill operation when he went through the Buffalo plant of the Republic Steel Corporation. D. B. Gillies, vice president, told the governor that for the past thirty-two months Republic has been operating at an average rate of more than 100 per cent of production.

Frank C. Farrell, Republic's Buffalo district manager, acted as host to the governor and told him that steel from the Buffalo plant is being used in rifle barrels, for shells, for airplane landing mats, gun mounts, and many other war materials.

Mr. Gillies also told Governor Dewey that Republic employs approximately ten thousand people in the state of New York and has operations not only in Buffalo, but in New York City, Brooklyn, Troy, Mineville, Lyon Mountain and Port Henry. The latter three are iron ore mines.

In this photograph the governor is taking his first look at the molten metal in an open hearth furnace.

The most effective defense against leakage on all vital flow-lines in steel plants

—for controlling gas, oil, residues, air and water

Sizes: ½" to 30".

—for all temperatures

—all pressures

NORDSTROM *Lubricated* PLUG VALVES

Leaking valves are the saboteurs of production. Keep flow lines flowing by installing positive action, positive sealing Nordstrom Valves. Keep upkeep down.

Nordstroms meet every major valve need. Lubrication under pressure keeps these valves in prime condition, making them easy to turn, and also sealing the ports against leakage.

MERCO NORDSTROM VALVE COMPANY *A Subsidiary of Pittsburgh Equitable Meter Co.*

Main Offices: 400 Lexington Ave., Pittsburgh, Penna. Branch Offices in Principal Cities

MAINTENANCE MANUALS

▲ The General Electric Company has announced the availability of complete and comprehensive manuals on how to maintain motors, generators, and control.

No industry knows better than the steel industry the importance of proper maintenance of electric equipment. A shutdown for any reason is very costly from a production standpoint. Maintenance these days is even more important than usual because of the urgent need for steel for the war effort and because of the difficulty of getting new equipment.

And yet, proper upkeep is difficult to maintain, with new and inexperienced men frequently replacing those who have gone into other activities or into the fighting forces. The new maintenance manuals are expected to be of real help in the training of new maintenance men and in saving time for experienced ones.

In these manuals are found:

1. A preventive maintenance schedule for each of the different kinds of motors and control;
2. A section which gives, in detail, procedures to follow in the correct maintenance of the equipment.
3. Trouble-shooting charts which outline a procedure for quickly locating troubles.

The manual on motors and generators is identified as GET-1202, and the one on control as GET-1195. Other manuals on how to maintain rectifiers, insulation varnish and compounds, how to maintain welders, and how to maintain electric furnaces, are also being prepared.

FILTRATION UNITS RECLAIM USED OIL

▲ A new illustrated folder describing their A and GH lines of lubricating and hydraulic oil reclaimers is now ready for distribution to anyone having a problem in oil reclaiming, it was announced by the Youngstown-Miller Company, Sandusky, Ohio.

This bulletin covers YM oil reclaimers with capacities ranging from 2½ gallons in 70 to 90 minutes to 120 gallons in the same length of time.

These reclaimers are recommended for restoring all types of used oils, including oils drained from aircraft engines, diesel locomotives, marine stationary diesel engines, hydraulic machines, gear reducers, compressors, portable diesels, gasoline engines, gas engines, ice machines, vacuum pumps and similar installations.

There are eleven different models in these two series — both types using contact filtration in which common refinery earths available on the open market are utilized. The machines have a two-stage filter press, are semi-automatic (operating under thermostatic control) and thus permit the man operating the machine to do so incident to his regular work. The machines are said to be capable of reclaiming used oils without presettling or pretreatment and restoring the oil to substantially the same values of fire, flash, viscosity, color, neutralization number and precipitation number as the new parent oil.

In addition to the models described in this bulletin, the company builds larger machines for special requirements.

MANEUVERABILITY *PLUS* for your billet hauling! Reversible—either end pull, four steerable wheels. For two wheel steering, merely lock either turntable and remove crossrods.

Timken-Roller Bearings. 10 Ton Capacity. No tracks required.

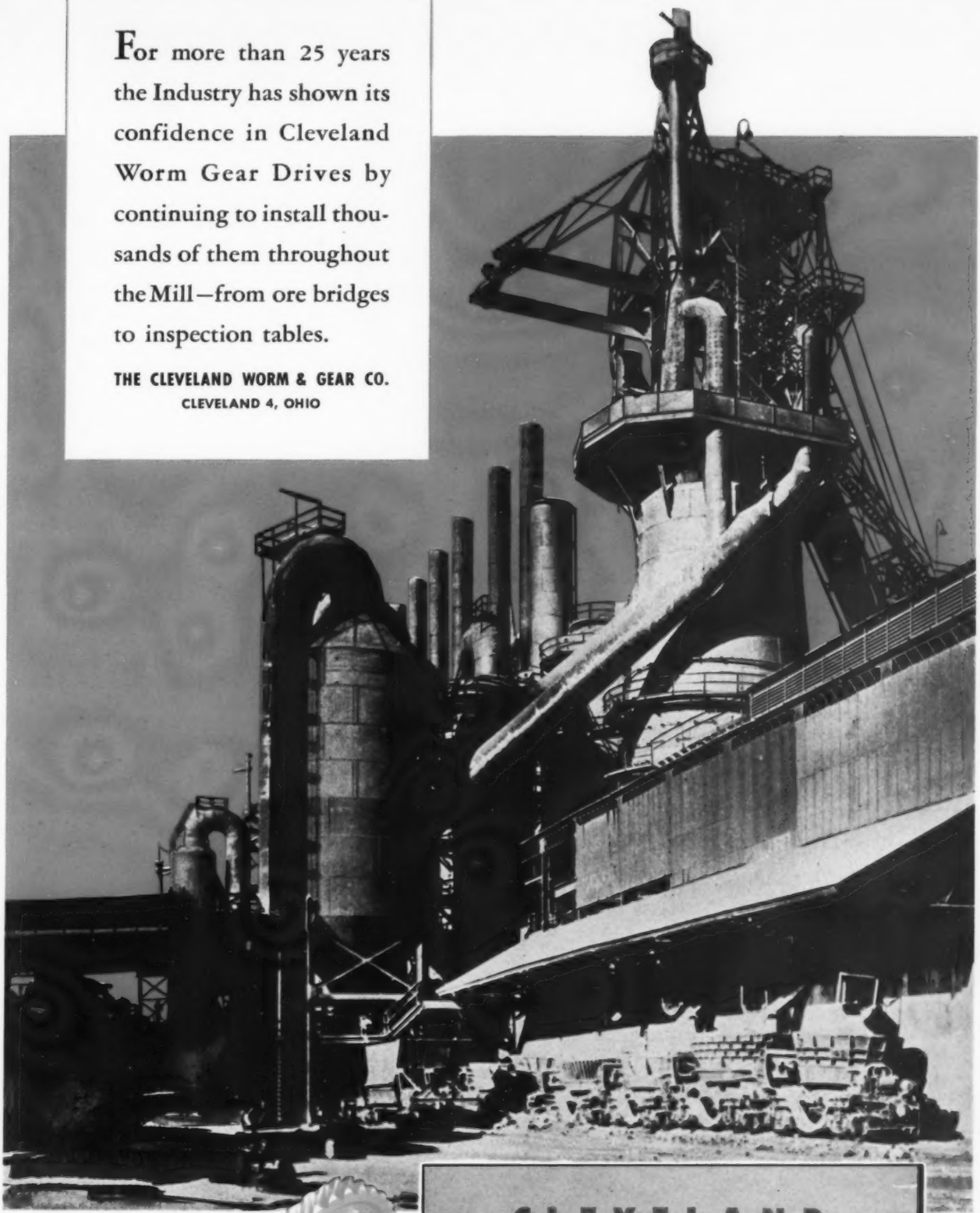
Have Phillips Billet Trailer move in and speed your war essential billet handling!

MANUFACTURERS SINCE 1863 — PHILLIPS MINE AND MILL SUPPLY COMPANY — PITTSBURGH, PENNA.

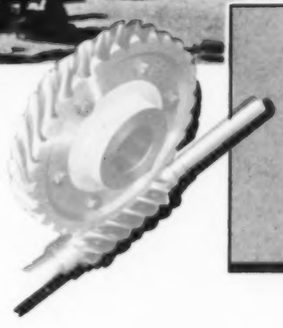
MINE & INDUSTRIAL CARS—FABRICATED STEEL—IRON CASTINGS

For more than 25 years the Industry has shown its confidence in Cleveland Worm Gear Drives by continuing to install thousands of them throughout the Mill—from ore bridges to inspection tables.

THE CLEVELAND WORM & GEAR CO.
CLEVELAND 4, OHIO

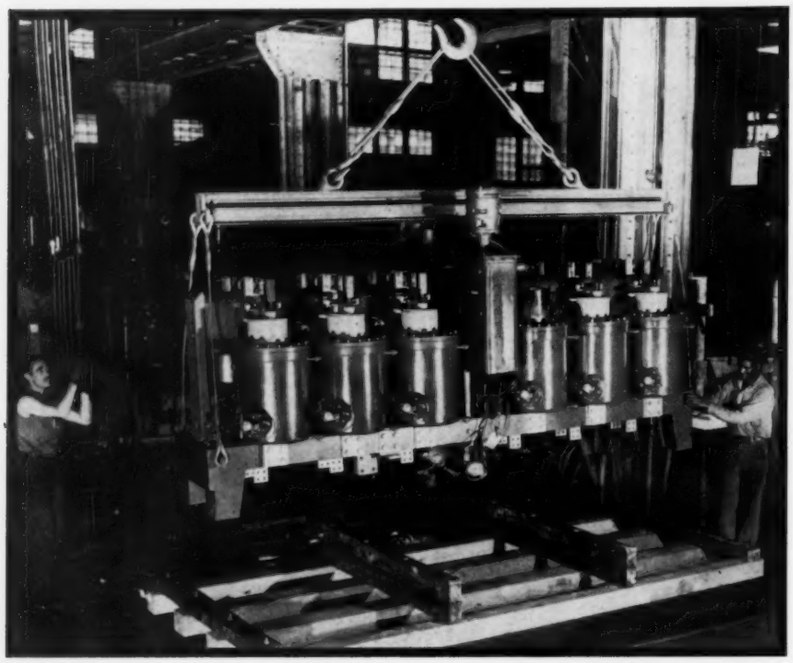


Courtesy of Republic Steel Corporation



CLEVELAND
WORM GEAR
SPEED REDUCERS

MERCURY ARC RECTIFIER FOR KAISER PLANT



Converting alternating current supplied by power lines to direct current required in the new Kaiser steel mill at Fontana, California, will be the function of this 1500-kilowatt mercury arc rectifier shown being packed for shipment from a General Electric plant. With two 1000-kilowatt G-E rectifiers, one already shipped and another now under construction, this rectifier will convert power for auxiliaries including table rolls, levelers, conveyors, and other equipment in the Kaiser plant.

New Literature

▲ A new standard put out by the American Standards Association covers graphical symbols for power, control and measurement. The standardization of symbols on wiring diagrams will do much to relieve the headaches of electrical engineers who are forced to read the diagrams prepared by various manufacturers, and these men are unanimous in recommending the adoption of a standard. The new code, Z 32.3-1943, "American Standards for Graphical Symbols for Power, Control and Measurement," is published by the American Institute of Electrical Engineers, 33 W. 39th Street, New York. The price is 40 cents.

Another publication useful to electrical engineers is the "American Standard Specifications for Weather-resistant Wire and Cable," which is available at a cost of 25 cents from the American Standards Association, 29 W. 39th Street, New York.

▲ "Metals and Alloys Data Book," by S. L. Hoyt, is a collection of data on important metals and alloys for metallurgists, engineers, students and others who use such information. The outgrowth of the author's personal accumulation, the material is presented in concentrated tabular style, descriptive matter being omitted. The book is intended for information, not instruction. Published by Reinhold Publishing Corporation, New York. 334 pages. Price, $4.75.

▲ The Farval Corporation has published an 8-page bulletin "the Multival system," described as an improved method of providing positive lubrication to a group of bearings from a central distributing block.

Like other Farval equipment this system delivers lubricant to individual bearings under pressure. With Multival however, oil or grease is supplied to the multiple valve blocks by means of a manual or power-operated portable gun. By making a single connection the operator delivers an exact measured charge of lubricant to as many as 10 bearings at a time. Each bearing receives the correct amount, regardless of its location or condition and not a bearing is missed.

The Multival block is pictured in phantom to illustrate the measuring and distributing mechanism and the operation of the tell-tale indicator which signals that the bearing has been filled with lubricant under pressure. Two pages are devoted to photographs and drawings of the various fittings by which Multival system can be installed on a wide variety of machines. Other Farval manual and power systems are shown, with a directory of cities in which the company maintains sales and service offices.

▲ A new bulletin just issued by the Watson-Stillman Company, of Roselle, New Jersey, offers a most comprehensive coverage of its line of Stediflo hydraulic pressure pumps. The illustrations show several of the more popular models, with separate illustrations of the important parts.

Stediflo pumps are available in standard sizes from 3 to 200 horsepower for pressures of 1,500 to 10,000 lb per sq in. and upward. They are furnished with plain or tank bases to suit individual requirements. Sizes of 3 to 40 horsepower are driven by gear-head motors. The larger size pumps, from 60 to 200 horsepower, are equipped with built-in reduction gear units, either single or double reduction, to suit motor speed. Reduction gearing permits the motor to be mounted on top of the pump, making a very compact unit.

WANTED

High Grade Design Engineer of Steel Mill Machinery. Should be able to design machines from rough sketches and ideas.

If employed now in essential war job and not available immediately, change could be deferred until a later date.

Applicant please give full details as to past experience and salary expected.

The Wean Engineering Co. Inc.
WARREN, OHIO

Yes, Heppenstall Automatic Safe-T-Tongs mean definitely faster materials handling---and safer---and more economical handling. Whether it's a load like this

or a load like this

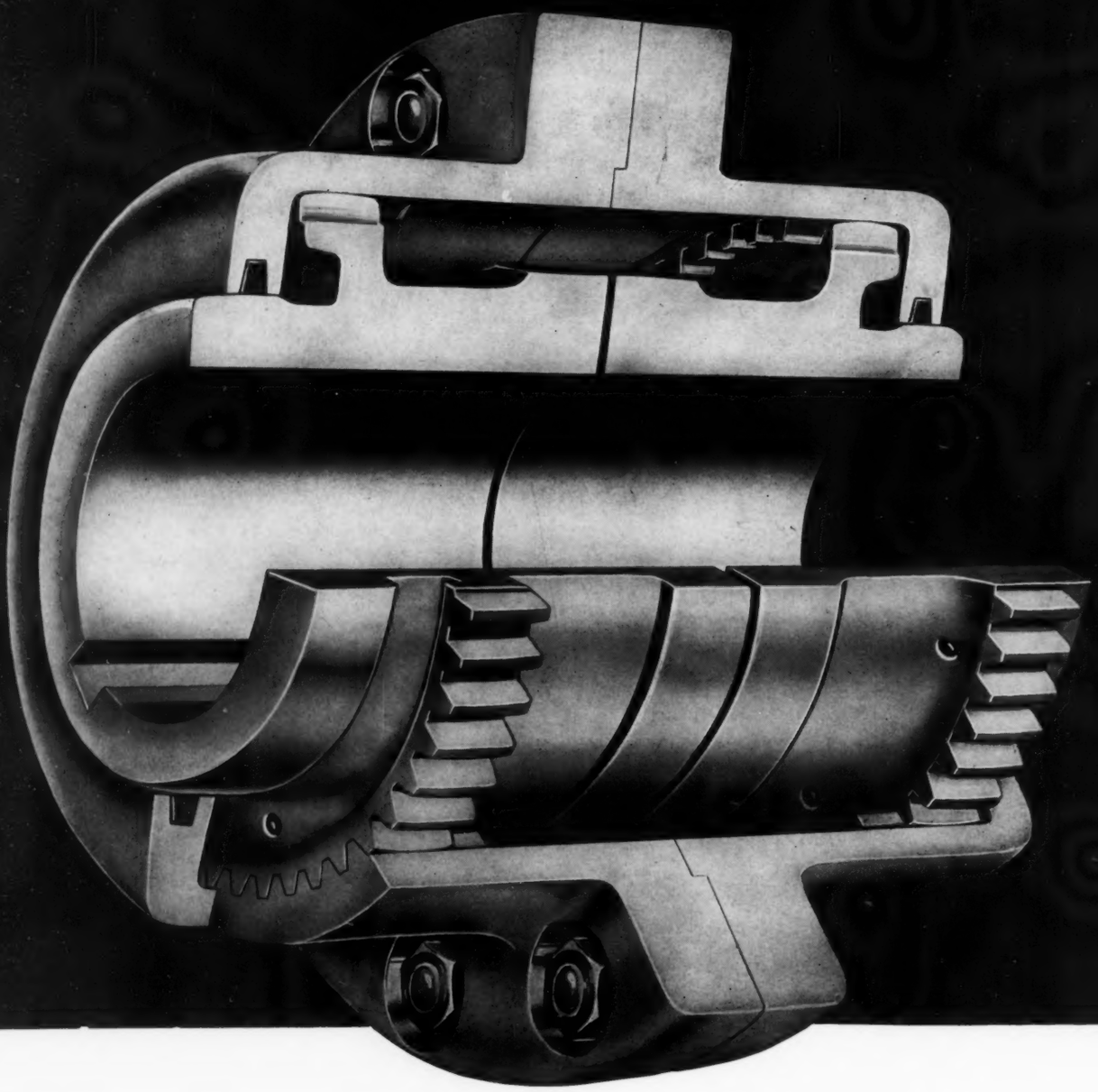
takes no difference because Automatic Safe-T-Tongs are designed specifically for each job.

Safe-T-Tongs are safe and sure and easy to operate . . . fully automatic, not power driven . . . no chains ever to burn or crush. Here is the way they work: First, you lower them on the object [illegible] ... other block and the tongs unlock [illegible] ... the tongs grip as they rest on [illegible] ... every material ... then as the load is placed, the tongs lock open again automatically ready for the next job. Why not write for this highly descriptive book about tongs?

It may give you ideas. Department VI, Heppenstall Company, Pittsburgh.

Heppenstall Automatic Safe-T-Tongs

POOLE



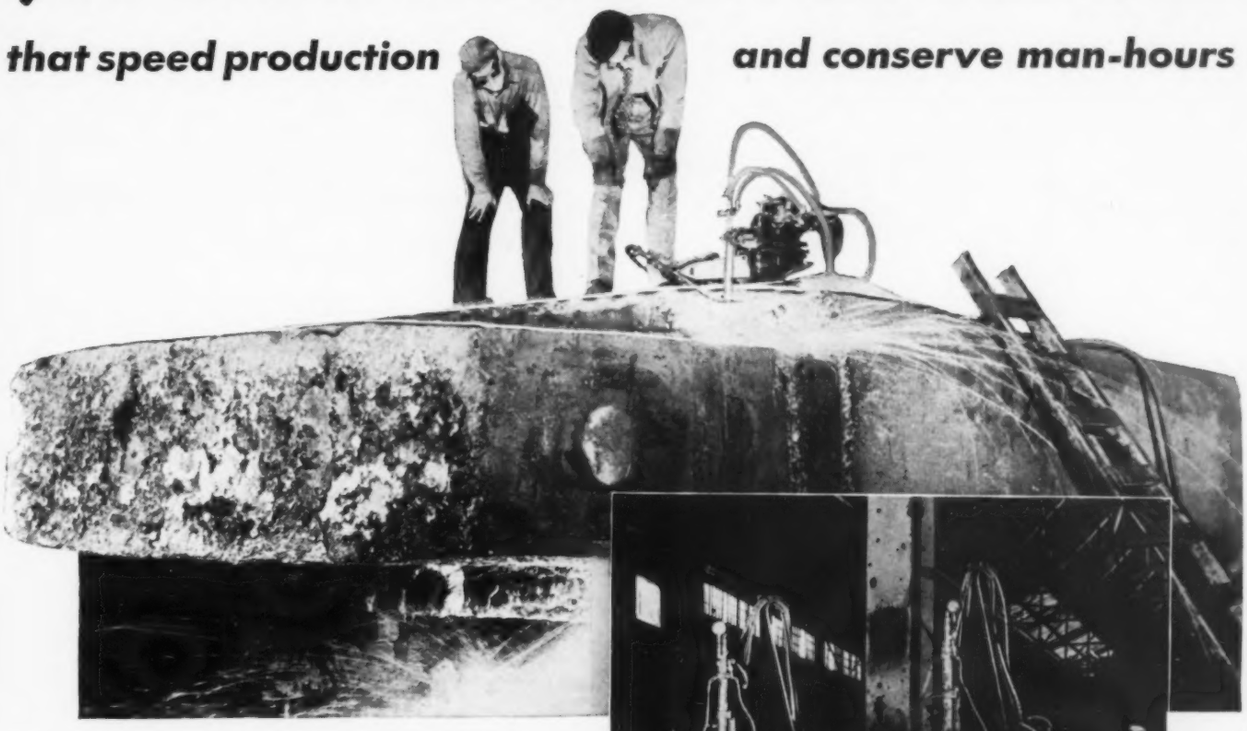
A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

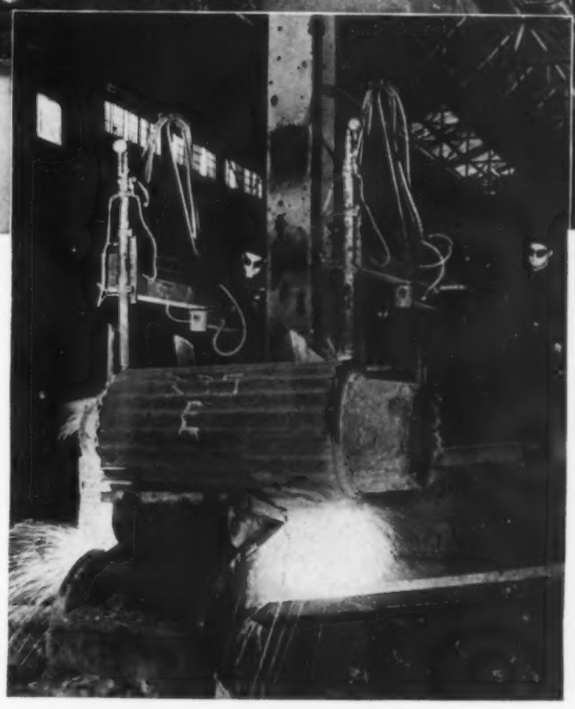
FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

Two more FLAME-CUTTING METHODS

that speed production and conserve man-hours





HERE are two recent flame-cutting developments that show the ever-expanding usefulness of oxy-acetylene flame methods.

At top an Airco No. 4 Radiagraph machine is shown cutting an alloy steel ingot 12′ square—*and 52″ thick!* This Radiagraph is fitted with a standard Airco heavy duty cutting torch, equipped with a pressure indicator gauge at the cutting torch. Cutting speeds here were 2-1/2″ per minute.

At the right, a new Airco ingot-cutting machine crops both ends simultaneously off a 32″ diameter ingot. This machine flame-cuts corrugated ingots up to 36″ in diameter in fast time.

Many other familiar oxyacetylene processes such as flame scarfing of slabs and billets, flame descaling of blooms and ingots, scrap-cutting and maintenance welding are speeding steel production and saving man-hours and costs.

For further information on modern flame-cutting methods—or technical assistance in their applications—call or write to your nearest Air Reduction office.

★ ★ ★

BUY UNITED STATES WAR BONDS

Air Reduction

General Offices: **60 EAST 42nd ST., NEW YORK 17, N. Y.**

IN TEXAS: MAGNOLIA AIRCO GAS PRODUCTS CO.

General Offices: **HOUSTON, TEXAS**

IDLE CYLINDERS ARE PRODUCTION SLACKERS: *Keep 'em rolling for victory!*

ITEMS OF INTEREST

P. S. Jones has been appointed as general sales manager of Cutler-Hammer, Inc., Milwaukee. In his new duties Mr. Jones will have direct supervision of sales for the company through its thirty selling territories throughout the country.

Mr. Jones first became associated with the company at Milwaukee as a sales engineer in 1915, and he was transferred to the Pittsburgh office in 1919, where he was later appointed as branch manager of the Pittsburgh sales territory. For the past fourteen years prior to his new appointment Mr. Jones was in charge of the New York sales territory.

Mr. Jones is a graduate of the Ohio State University where he obtained his B.E.E. in 1915.

P. S. JONES

W. H. Richardson has been appointed as general manager of all activities of all divisions of The Timken Roller Bearing Company on the entire West Coast and in the Orient.

Mr. Richardson came with The Timken Roller Bearing Company in 1917, serving in various sales capacities until 1929 when he was made manager of The Timken Roller Bearing Service and Sales Company, and vice president of The Timken Roller Bearing Company Limited, Canada.

In 1941 he was made assistant general sales manager of The Timken Roller Bearing Company and has been devoting much of his time to study of the development of the post-war markets for the various products of the company.

Dan Schaitberger has been made sales manager of the Northern Engineering Works, Detroit, Michigan, makers of Northern Hi-Lift Hoists and Northern Cranes.

Mr. Schaitberger has been with the company for 16 years, starting in 1927 as salesman. Previous to this appointment, he has been sales engineer for a number of years.

A. G. Fournier, formerly connected with the Howell Electric Motor Company is now district representative of The Rowan Controller Company in California. Mr. Fournier was associated with the Howell Electric Motor Company for approximately fifteen years in sales and service. As district representative of The Rowan Controller Company Mr. Fournier will be able to assist in the application of Rowan control in the California territory. His office address is 2444 East 24th Street, Los Angeles 11, California.

T. H. Wickenden has been appointed as manager of the development and research division of the International Nickel Company and **H. J. French** as assistant manager.

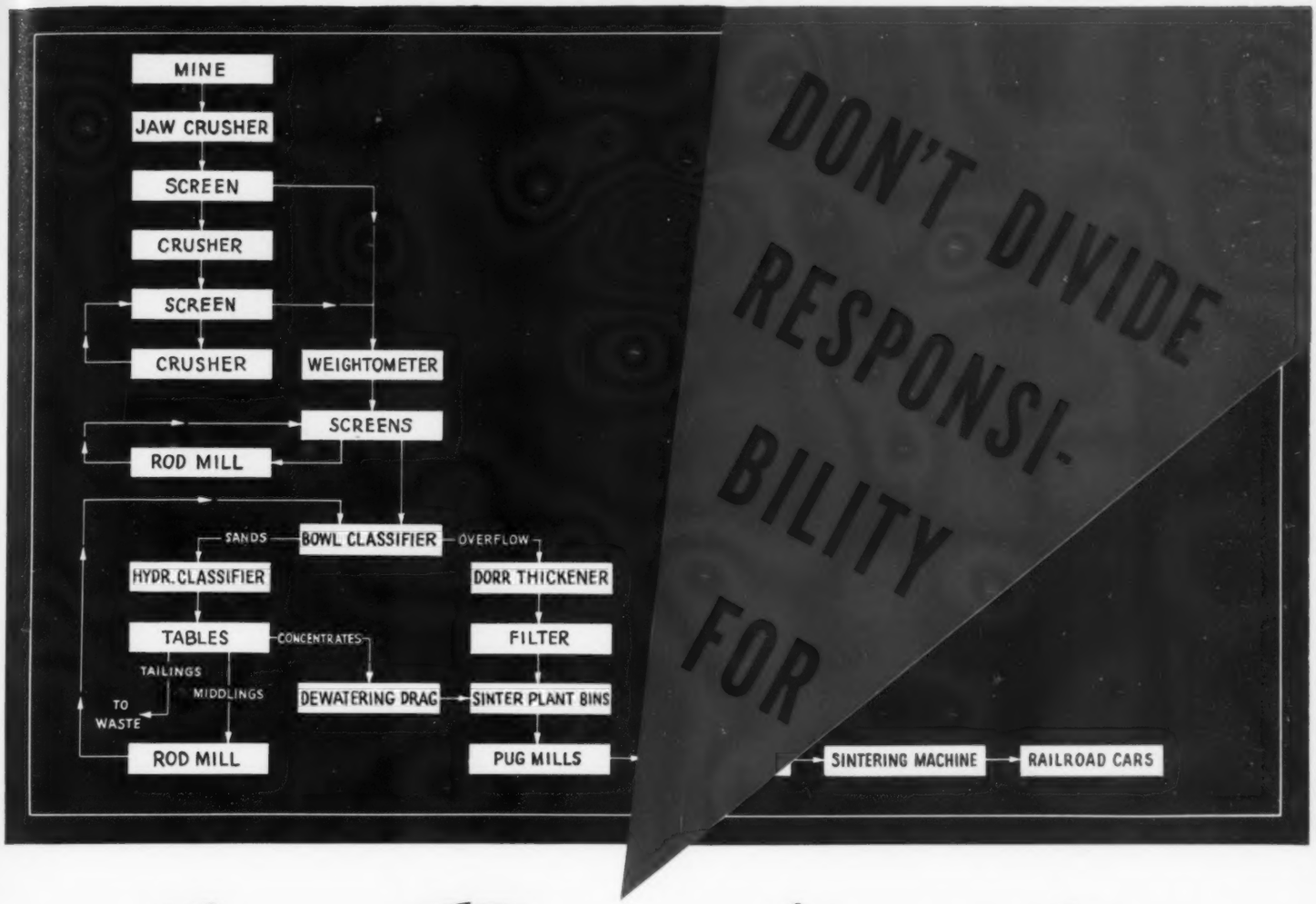
Mr. Wickenden, who has been assistant manager of the Division since 1931, succeeds the late Albion James Wadhams. He is well known in engineering circles in the automotive industry, having been in charge of engineering at Studebaker Corporation's South Bend plant from 1913 to 1920. Mr. Wickenden joined International Nickel in 1922 when he was placed in charge of developments in the automobile field for the development and research department at New York.

W. H. RICHARDSON

A native of Toledo, Ohio, he attended Denison University, Granville, Ohio, and received his engineering degree at the University of Michigan.

Fred F. Murray has been elected president of the Oil Well Supply Company, subsidiary of United States Steel Corporation.

Mr. Murray succeeds Benjamin F. Harris of Pittsburgh, Pennsylvania, who resigned several months ago. Mr. Murray has been identified with the Oil Well Supply business since early 1929, in which year be became vice president of Wilson-Snyder Manufacturing Company of Pittsburgh, Pennsylvania. Wilson-Snyder was acquired the same year by Oil Well Supply Company, with Mr. Murray being elected vice president in charge of manufacturing of Oil Well Supply Company at Oil City, Pennsylvania. In 1930 Oil Well Supply Company became a U. S. Steel subsidiary, and early in 1936 Mr. Murray moved to Dallas as Oil Well's ranking vice president.



Ore Beneficiation

THE MODERN ore beneficiation plant is a highly complex arrangement of ore treating equipment integrated by plant design.

The McKee organization assumes responsibility for all phases of your project under a single contract.

To *divide* responsibility is to invite inefficiency in plant design and construction and improper correlation and installation of equipment, resulting in a plant which will *not* give you the best performance at the lowest cost.

McKee *Undivided Responsibility assures* you a plant of correct design to produce the best possible product at lowest operating cost.

Undivided Responsibility in **One Organization**

Arthur G. McKee & Company

★ *Engineers and Contractors* ★

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30 ROCKEFELLER PLAZA, NEW YORK, N. Y.

COMMERCE BUILDING, HOUSTON, TEXAS

THE WAPAKONETA MACHINE CO.
Incorporated 1891 — Wapakoneta, Ohio.

STAMPING MULTIPLE CHARACTERS

with Matthews **'Champion' HOLDER**

Made for hand stamping or press use... Matthews 'Champion' Holder can be used for 90% of all heavy or medium duty marking applications. Type changing is amazingly fast... marking is clean cut and in alignment. Write for Catalog 146-A for full particulars.

FOR HAND STAMPING

JAS. H. MATTHEWS & CO.

3982 Forbes Street — Pittsburgh, Pa.

Branch Plants
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Walther Mathesius, vice president in charge of operations of U. S. Steel Corporation of Delaware, has been appointed as president and a director of Geneva Steel Company, U. S. Steel subsidiary, recently organ-

WALTHER MATHESIUS

ized to operate the new $180,000,000.00 Defense Plant Corporation steel works at Geneva, Utah. Other officers elected, all of whom will serve as members of the Board of Directors are J. R. Gregory, vice president, sales; J. E. Butler, controller; J. Wohlend, treasurer and Merrill Russell, secretary and general attorney. Headquarters of the company will be located at Geneva.

Mr. Mathesius, who will build the organization of the new company, preparatory to expected operations of the plant late this year, has been with the U. S. Steel Corporation since 1911. He served as general superintendent of Carnegie-Illinois Steel Corporation, South Chicago Works, and in 1935 he was made manager of operations of the Chicago District of the same U. S. Steel subsidiary.

Thomas D. Williams has been appointed superintendent of construction of American Steel and Wire Company, U. S. Steel subsidiary. At the same time, **James McCulloch** has been named assistant superintendent of construction.

Born in Cleveland, Ohio, Mr. Williams' first employment was with Cleveland Rolling Mills, predecessor company of American Steel and Wire Company, in July, 1898, when he was employed as an office boy. Since then, Mr. Williams has held various positions at the company's Newburgh Works, Cuyahoga Works and the city office, his latest post being assistant superintendent of construction which he has held since August, 1941.

Mr. McCulloch was born in Scotland and has worked for American Steel and Wire Company since July, 1915, when he was employed as a concrete inspector at the Donora (Pennsylvania) Zinc Works. He held various other positions before being transferred to the chief engineer's office in Cleveland in August, 1937.

Robert G. Glass, of Chicago, has been elected a director of the Geneva Steel Company, and vice president and manager of operations of this new Utah subsidiary of United States Steel Corporation, it was announced recently by Walther Mathesius, Geneva Steel president.

Mr. Glass, who has been assistant manager of operations, Chicago District, Carnegie-Illinois Steel Corporation, first entered the services of United States Steel subsidiaries with the Illinois Steel Company, when in

ROBERT G. GLASS

1912 he became a member of the inspection department. He was advanced to assistant manager of the inspection department in 1923. He became assistant to the manager of operations in the Chicago District in 1936 and in 1941 was promoted to the position he has held until this time. Mr. Glass is a graduate in civil engineering of Ohio State University.

THE SONG OF
VICTORY
IS BEING PLAYED
In the Steel Mills
NEARLY ALL OF WHICH USE
BOWSER
OILING SYSTEMS
Bowser Oil Conditioner for turbine and similar oils requiring acid correction.
The Figure 829 Self-contained system. Made in many sizes and types.
Automatic, self-cleaning filter for lubricating oils and coolants.
DESIGNERS
•
ENGINEERS
•
MANUFACTURERS
BOWSER
The roar of blast furnaces . . . the whirr of gears, hiss of coolants on hot plates . . . the rumble of rolls . . . the hum of generators . . . and the calls of men . . . that's the song and music that is breaking Axis hearts . . . and bringing joy to the faces of our fighting men. For those sounds mean that more guns and jeeps, boats and barges . . . planes and tanks . . . bombs and bullets are coming in an unending stream to hasten the day of "unconditional surrender". Bowser is proud of the part it has played in helping to keep wheels turning in practically all of America's steel, brass and aluminum mills for half a century.
S. F. BOWSER & COMPANY
FORT WAYNE, INDIANA
MAKERS OF AMERICA'S NUMBER 1 OILING SYSTEMS

• PROTECT MILL EQUIPMENT

with R&IE *Enclosed*

SEGREGATED BUS -

CHECK THE FACTS - -

1. Cylindrical, isolated phase bus, individually housed to prevent interphase short circuits.
2. Mounting frames take all stresses. Bus easily mounted on wall, floor, or ceiling or other structures. Housings are enclosures only.
3. Insulators are used only in compression. All insulators are interchangeable.
4. Conductors supported by sleeve can be either anchored for fixed position or allowed to slide for expansion position. Conductors can be square, round, channel or bar, bare or insulated.

Enclosed
ISOLATED PHASE
Bus

An original R&IE development. This new type of bus is suitable for any voltage and current. It offers greater safety, flexibility, ease of installation and inspection, than any other type of bus arrangement. Conductors may be installed, aligned, adjusted and inspected before covers are attached. Inspection is possible at any time, at any location, by removing a few bolts and cover.

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COMPLETE SUBSTATIONS

OPERATING MECHANISMS

DISCONNECTING SWITCHES

AIR BREAK SWITCHES

CONNECTORS

BUS CLAMPS

CUTOUTS

THERMO-RUPTERS

METAL HOUSED, ISOLATED BUS

AUTOMATIC THROW-OVER EQUIPMENT

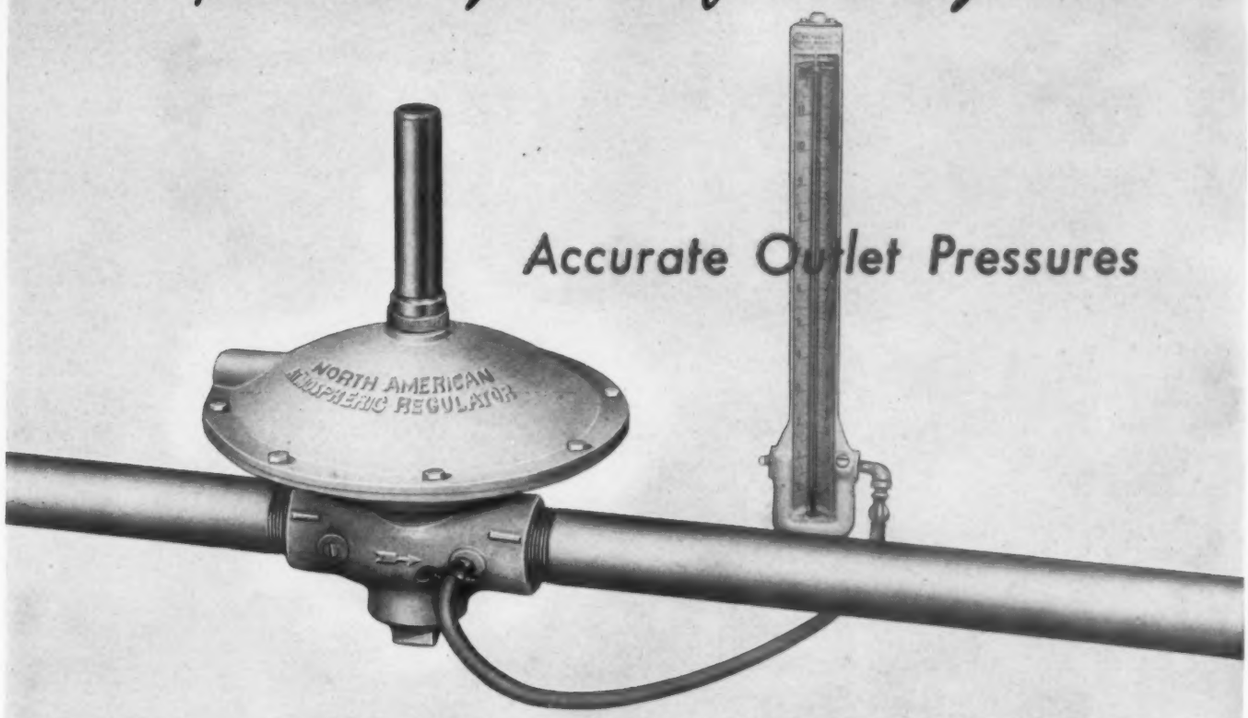
METAL CUBICLES

INTERLOCKS

TESTING DEVICES

NORTH AMERICAN

Atmospheric Regulators for Air-Gas Ratio



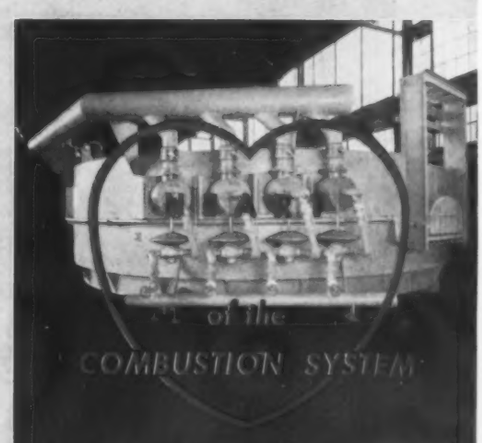
Accurate Outlet Pressures

Because—

In the NORTH AMERICAN Pressure System of fuel-air proportioning, the air valve controls the amount of fire. The fuel-air ratio remains constant because of the excellent operating accuracy of the NORTH AMERICAN Atmospheric Regulator. Any change, however small, in air pressure produces a proportional change in the flow of gas.

The NORTH AMERICAN Atmospheric Regulators are precision-built instruments—each one carefully checked and tested under actual operating conditions at the factory. A special flexible joint between valve and valve stem, special synthetic diaphragms, and a 1 to 1 ratio of the areas of the valve and small diaphragm are three additional reasons for the extreme accuracy of performance.

"NORTH AMERICAN for COMBUSTION"



Constant and correct gas-air ratio gives maximum heat for the amount of gas burned and uniform product resulting from constant furnace atmosphere.

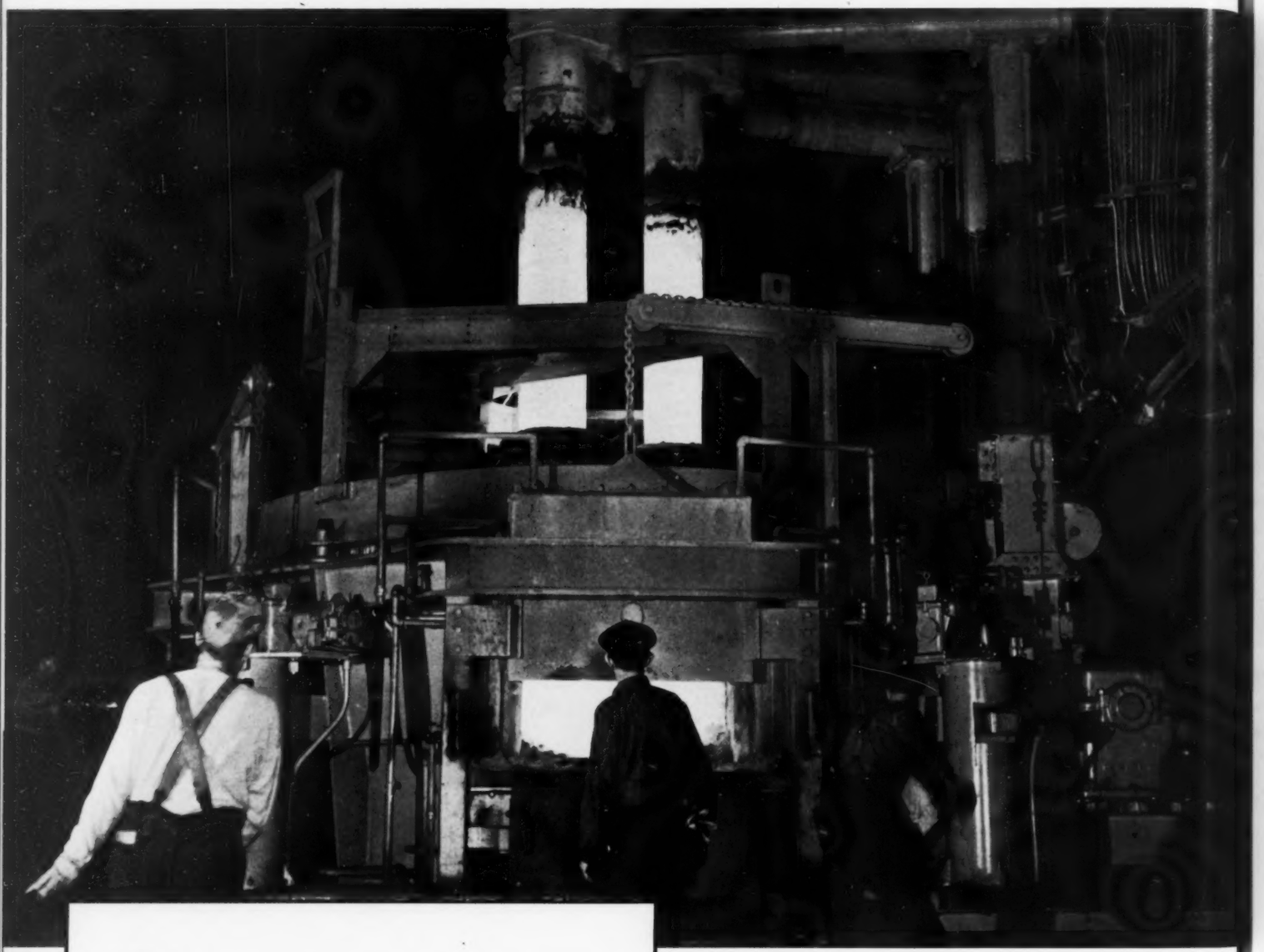
THE NORTH AMERICAN MANUFACTURING COMPANY

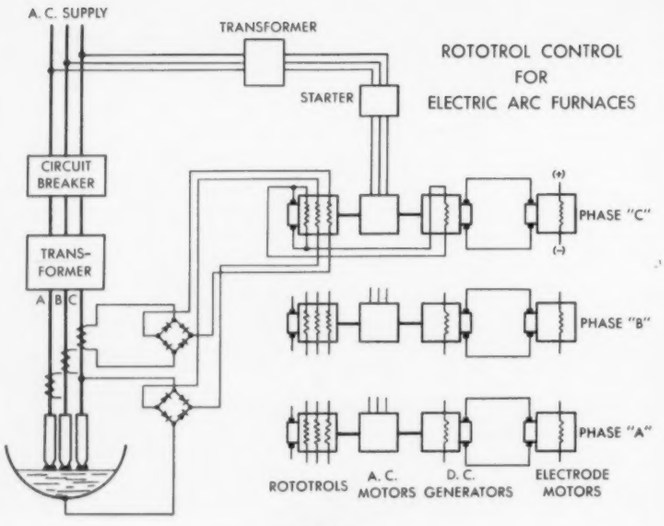
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL

BRANCH OFFICES *with* FIELD ENGINEERS *in* PRINCIPAL CITIES

CLEVELAND, OHIO

smooth electrode control . . .





HOW IT WORKS

As shown in the diagram, one field in the ROTOTROL is energized through a Rectox rectifier from a current transformer in the electrode circuit.

A second field is energized from the voltage across the electrode to the shell of the furnace.

These two fields operate differentially so that the magnitude and polarity of the output voltage of the ROTOTROL is thus a function of their inequality.

A third ROTOTROL field provides a high degree of amplification to any such differential, and the resultant magnified output voltage from the armature of the ROTOTROL is applied directly to the field of a variable-voltage generator which supplies power to the electrode motor.

WESTINGHOUSE

. . . with Rototrol

Another furnace electrode control using **BASIC WESTINGHOUSE PRINCIPLES OF 20 YEARS' STANDING** is available.

Regulation of arc furnace electrode position is based on the principle of balancing current in the electrode against voltage across the arc. This principle is a *basic* Westinghouse *development*.

With this principle is combined the use of variable voltage for control of the electrode motors, applied through the **ROTOTROL**, likewise a Westinghouse developed device. This combination provides rapid, positive, yet smooth positioning of furnace electrodes.

The entire control is accomplished by a few simple, substantial devices. A minimum of external connections and erection time is required. After installation no further adjustment is needed. Enclosed construction gives protection from dirt and physical damage.

The principle of **ROTOTROL** is old. Its first application was made in the early twenties to an automatic welding head, controlling the rate of feed of welding rod. This pioneering use was quickly followed by a variety of regulator applications which include sky-scraper elevator control, reversing planer drives, electric shovels, skip hoists and continuous winding of strip.

Investigate this positive, smooth electrical method of controlling electrode position. Your near-by Westinghouse office can provide full information. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. J-94600

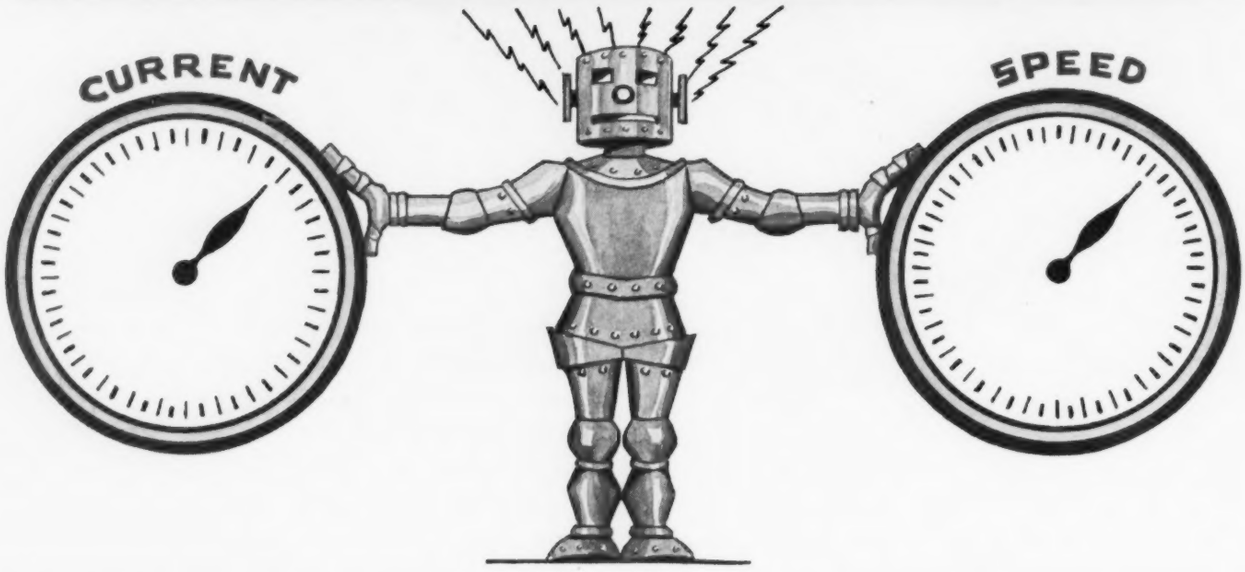
Westinghouse

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

This unit supplies variable-voltage d-c power to the motors which raise and lower the furnace electrodes. The **ROTOTROL** itself is essentially a d-c machine with several field windings. Interaction of these fields provides a high degree of amplification in the output voltage used to excite the d-c generator supplying power to the electrode motors. The **ROTOTROL** regulator provides the high degree of sensitivity, amplification, speed of response and stability required for arc furnace operation.

ROTOTROL A. C. MOTOR D. C. GENERATOR

CLARKTRONIC REGULATORS



¶ Clarktronic Regulators are Electronic Devices designed to maintain and control the relation of speed, current or voltage to a basic operation such as speed.

¶ Clarktronic Regulators provide performance that existing electric regulating devices cannot supply.

¶ A variety of applications, where extreme accuracy is needed, are possible. Used at present to control current vs Speed, other applications are to control speed, temperature, light output, voltage, and allied functions.

¶ Clarktronic Regulators are simple in construction, with a minimum of wearing parts, thus presenting no maintenance problem. They are practically instantaneous in response, and extremely accurate in performance.

¶ *For further information, please forward inquiries with complete application data, to the address below.*

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, 10, OHIO

EVERY MONTH YOUR MACHINES ARE FOUR MONTHS OLDER...

FORTIFY THEM WITH

OIL WITH GUTS

It's simple arithmetic that 168 hours a week is more than four times the old 40-hour week, and that your machines, unless wisely lubricated, will wear out more than four times as fast today. That those over-worked machines are able to take this punishment is a tribute to their designers, to hard-pressed plant executives who watch oil diet, and to makers of lubricants who have learned how to *fortify* them for this emergency.

Thanks to lubrication science, we "do things" to oils today that give them "guts", as the shop man expresses it. High film strength, high oiliness values, leak resistance, stability, high viscosity index—all these properties are being built into today's lubricants. Houghton provides that "extra" protection . . . has developed exclusive methods of processing and treatment that extend machine life. The Houghton Service Engineer is ready to help.

E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

High-film-strength, polymerized Sta-Put Lubricants ★ Dynamo-Turbine-Compressor D. L. Absorbed Oils ★ Fortified-film, stable, "High-V. I." Hydraulic Oils ★ Reversible, smooth Absorbed Oil Greases for Ball and Roller Bearings ★ E. P.-treated Spindle Oils ★ Stable, strong Diesel Engine Oils ★ Extreme-Pressure-treated Gear Oils, and a host of others for 24-Hour War Plant Duty.

A SINGLE OBJECTIVE.....

Production Control

A SINGLE RESPONSIBILITY IN ACHIEVING IT

Higher tonnage and uniform quality of product result from efficient control of steel mill equipment. An invaluable aid in achieving this is a system of automatic controls and instruments that allows operators to concentrate on the factors making for optimum production. To secure these results, Republic Flow Meters Co. offers a complete manufacturing and engineering service—a single responsibility—in the field of measurement and control. We will gladly co-operate with you in the solution of any metering or control problem. Your inquiries involve no obligation.

FURNACE CONTROLS
For furnace pressure, fuel, fuel-air ratio.

BOILER CONTROLS
For all boilers, all types of firing.

REGULATORS
For pressure, flow, speed, level, ratio.

GAS MIXER CONTROLS
For mixing gases in desired ratio.

COKE OVEN GAS CONTROLS
For collecting mains, stack draft, pressures.

RING-BALANCE METERS
For steam, water, gas, air, oil, etc.

ELECTRICAL FLOW METERS
For steam, water, gas, air, oil, etc.

FURNACE PRESSURE RECORDERS
For pressure in all types of furnaces.

DRAFT & PRESSURE INDICATORS
For draft, pressure, flow, temperature, CO_2, etc.

THERMOMETERS
For temperatures up to 1000 F.

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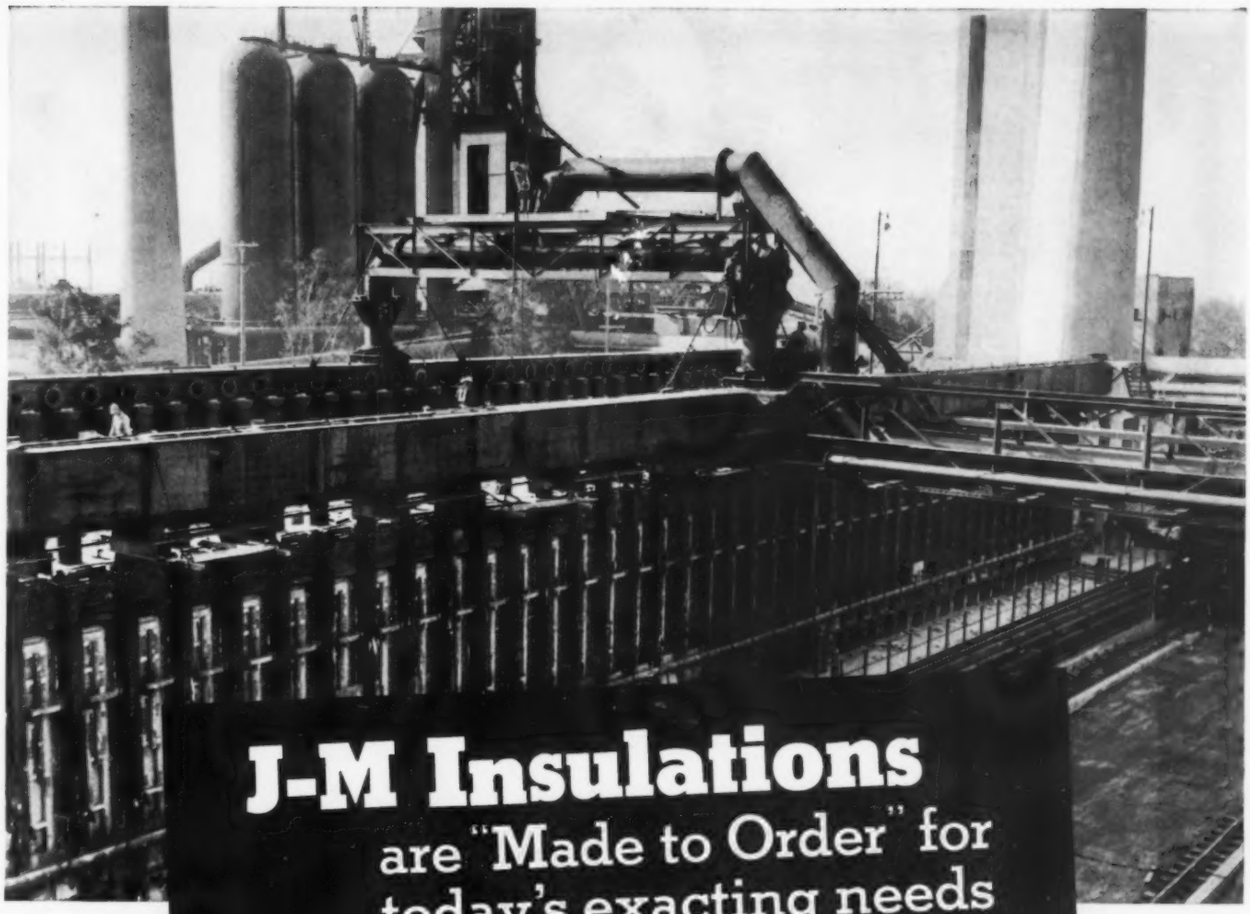


J-M Insulations
are "Made to Order" for today's exacting needs

J-M Industrial Insulations cover every type of heat control. Each type of insulation is tailor-made to fit the particular job for which it was designed. In addition: Johns-Manville's 85 years' experience in every conceivable type of insulation problem makes it possible for J-M Engineers to design insulation applications for special conditions with utmost speed, thoroughness and economy. Following are just a few of the many types of J-M Industrial Insulations:

INSULATION FOR TEMPERATURES TO 1900° F. J-M Superex Blocks have long been standard for this service. High heat resistance, low thermal conductivity. Sizes 3″ x 18″, 6″ x 36″ and 12″ x 36″; from 1″ to 4″ thick.

FURNACE INSULATION UP TO 2600° F. J-M Insulating Brick and Insulating Fire Brick are available in 7 types, with temperature limits ranging from 1600° F. to 2600° F. All provide light weight, low conductivity.

FOR TEMPERATURES TO 600° F. J-M 85% Magnesia has been for many years the most widely used block and pipe insulation for temperatures to 600° F. and, in combination with Superex, for higher temperatures. Maintains high insulating efficiency. Standard block sizes 3″ x 18″, 6″ x 36″ and 12″ x 36″; from 1″ to 4″ thick.

FOR STEAM LINES UP TO 700° F. J-M Asbesto-Sponge Felted Pipe Insulation is recommended where maximum efficiency, high salvage and resistance to abuse are essential. For temperatures over 700°, used in combination with Superex. It is available in 3-ft. lengths, from 1″ to 3″ thick, for standard pipe sizes.

SIL-O-CEL C-3 CONCRETE—Cast on the job from Sil-O-Cel C-3 aggregate and cement. Sets up into a strong, durable semi-refractory insulating concrete for temperatures up to 1800° F. Crushing strength: 1000 lbs. per sq. in.

For details on these materials, and on the complete J-M Insulation line, write for Catalog GI-6A. Johns-Manville, 22 East 40th Street, New York, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville
INDUSTRIAL INSULATIONS
FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE

Wagner

HYDRAULIC BRIDGE BRAKES

make crane operation safer and easier—

as expressed in the letter reproduced below, received from a mill worker employed in the plant of a well-known company.*

Wagner Electric Corp.,
St. Louis, Mo.

Dear Sirs: Recently a Wagner hydraulic brake was installed on a over-head crane I operate. This brake transformed my job from a nerve wracking grind, to a pleasant days work. No more brake chatter and vibration, which caused a break down ever so often, holding up production, as well as a tired out sick feeling at the end of every shift. With the Wagner hydraulic brake, I now can come to a smooth as well as an emergency stop; and depend on it to do just that. Anyone who operates a crane with a fairly fast run way speed, and averageing 300 lifts per shift would appreciate how important this is. After a dozen years of this work I find I enjoy doing it, thanks to your brake. Your company as well as mine are to be congratulated. You for building a fine piece of machinery, and my employer, for using the best.

*Name and address of writer will be sent upon request. (This letter is reproduced exactly as written).

143-6

Write for Complete Information . . .

Bulletin IU-20 gives full information on the two available types of Wagner Hydraulic Bridge Braking Systems—type H for inside cranes, and type HM for outside cranes where automatic parking is necessary.

Wagner Hydraulic Bridge Braking Systems are complete in every detail, including all necessary parts and equipment, and are ready for immediate installation on your cranes.

Wagner Electric Corporation
ESTABLISHED 1891
6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS

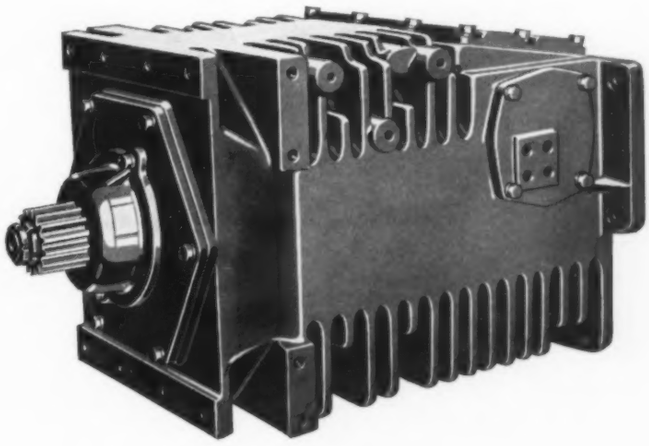
Pioneers found gold in "them thar hills"—Reliance engineers find it for you in new applications of motor-drive.

A 1-TON BUMP!

Our armed services needed an electric motor that would stand up under 2000 pound shocks. Reliance built it for them, at once!

Two things contributed to the prompt solution of this problem by Reliance engineers—a pioneering, open-minded approach to *all* motor-drive problems; and, a lot of experience with steel mill and mine motors that "take it" daily in installations subject to severe shocks.

When you have plans on the boards requiring motor-driven machines, call in a Reliance man—he is both Engineer and Pioneer. He can offer you practical suggestions, based on experience and ingenuity.



Reliance Fully-enclosed D-c. Mine Motor for coal-loading machines. Husky, compact, reliable—it "keeps the coal rolling".

RELIANCE A-C D-C MOTORS

RELIANCE ELECTRIC & ENGINEERING CO.

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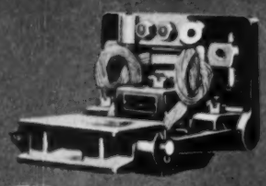
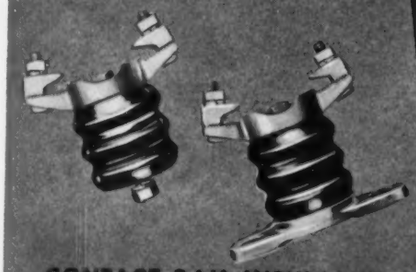
TRAVELING ELECTRICAL CONTACT
AND
HEAVY FEEDER SYSTEM MATERIALS



SHOES AND COLLECTORS



CONTACT RAIL INSULATORS

Headquarters

A complete line of contact rail material utilizing either rails, angles or wire as a conductor including numerous types of insulators for either under-running or over-running operation. You may also select from many types of current collectors including Junior, Universal and Pantagraph styles and contact rail shoes.

The Keystone line also includes numerous types of clamps and insulators for the insulation, suspension and dead-ending of heavy feeder cables.

These products are widely used in most large steel mills, being thoroughly proved in service. The complete catalog illustrated below will be very helpful to all interested in the construction or maintenance of cranes or feeder systems.

MANUFACTURED BY
ELECTRIC SERVICE SUPPLIES CO.
17th & CAMBRIA STREETS · PHILADELPHIA · PA.
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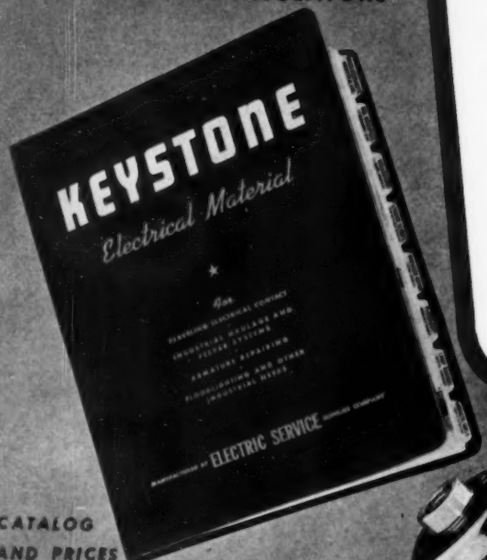
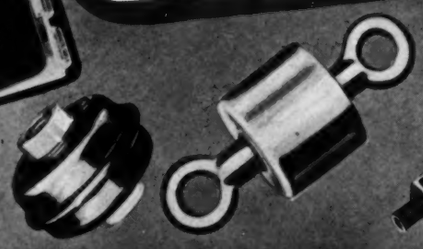
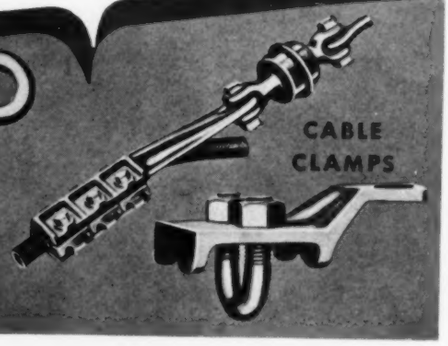


CATALOG AND PRICES SENT PROMPTLY ON REQUEST



GIANT STRAIN INSULATORS



CABLE CLAMPS

Since 1941

7 new tonnage records

with Technalloy Blooming Mill Rolls

Other Mackintosh-Hemphill Products:

Rolling Machinery . . . Shape Straighteners . . . Strip Coilers . . . Shears . . . Levellers . . . Pinions . . . Special Equipment . . . Iron-Steel Castings . . . The NEW Abramsen Straightener . . . Improved Johnston Patented Corrugated Cinder Pots and Supports . . . Heavy Duty Engine Lathes.

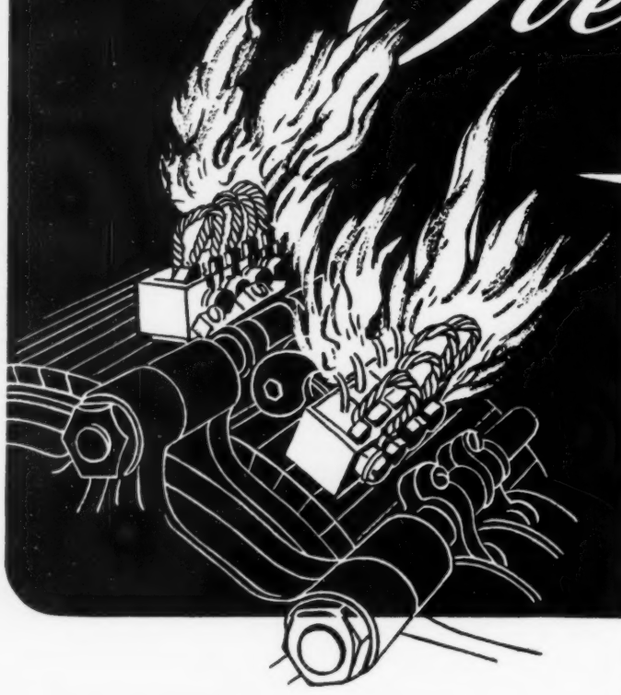
In seven mills, new tonnage records were set with Mackintosh-Hemphill Technalloy Blooming Mill Rolls, thus reducing costs. In two of these mills, the new tonnage records established were double those of the best previous performance.

M-H Technalloy Rolls are made of enriched true alloy steel; they are especially heat treated to produce the required hardness of the body surface and are tempered so as to toughen them to resist spalling and crumbling under pressure. The journals are tough and strong and well able to withstand the imposed stresses.

Save money and establish new tonnage records. Specify M-H Technalloy Rolls.

MACKINTOSH-HEMPHILL CO., Pittsburgh and Midland, Pa.

BRUSHES *Overheating?*



LOOK FOR THESE CAUSES

High temperatures hasten breakdown in brushes. To locate and remedy overheating, check for:

1. **Severe sparking**
2. **Unequal and incorrect brush pressures**
3. **Overloading**
4. **High friction brushes**
5. **Insufficient ventilation**
6. **Too high ratio of brush surface to commutator**
7. **Chattering**
8. **Short circuiting currents**

WHATEVER YOUR BRUSH TROUBLES *Consult* SPEER

Whether it's overheating, sparking, pitting, chattering — in fact, any cause of poor brush operation — you'll save time and avoid needless machine damage by getting SPEER recommendations. SPEER will speed your trouble-shooting, prescribe the brush grade best suited to your operating setup. SPEER is ready to focus forty-five years of commutation experience on your problem. Do this to receive our counsel:

Send for SPEER Brush Data Forms — one for each machine whose performance you want to better. We'll mail you these forms at once. Fill out and return them to us. Shortly after, you will receive our recommendations, which you may follow or not without obligation. We offer this service free, to help increase the effective use of power through better commutation. Write for any number of forms — on your business letterhead, please.

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CARBON COMPANY
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ST. MARYS, PA.
CHICAGO · CLEVELAND · DETROIT
MILWAUKEE · NEW YORK · PITTSBURGH

Courtesy of Republic Steel Corporation

THE enormous savings made by the Steel Industry through its use of Centralized Lubricating Systems to date, are small by comparison with the huge sums still to be realized from the same source.

THE FARVAL CORPORATION • Cleveland 4, Ohio

There are more Farval Systems installed on Steel Mill Equipment than all other makes combined.

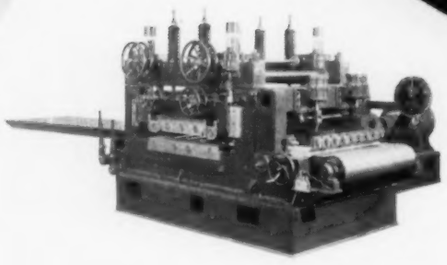
BLISS BUILT ROLLING MILL

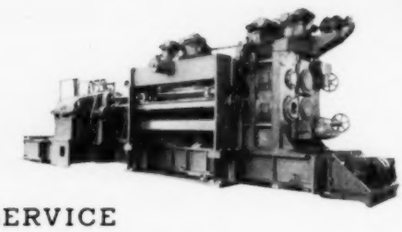
BROOKLYN, N. Y.

CLEVELAND, O.

SALEM, O.

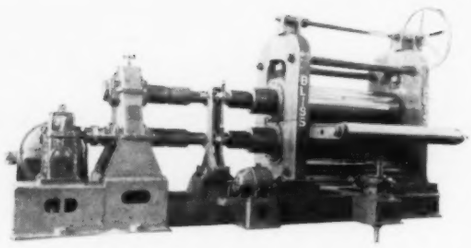
HASTINGS, MICH.





EQUIPPED FOR SERVICE

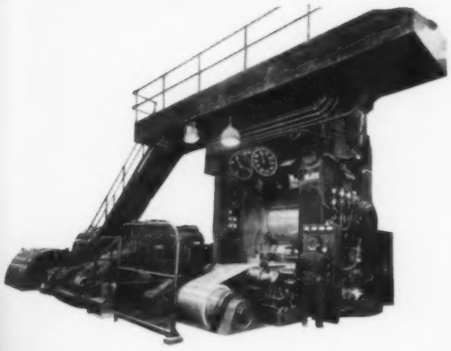
An earned reputation for sound engineering and precise workmanship in the construction of "Bliss Built" Rolling Mills and mill equipment is backed by one of the largest and oldest companies in the sheet metal working equipment field. "Bliss" Rolling Mill activities centered at the enlarged Salem plant are augmented by the heavy machining facilities of four other domestic plants.

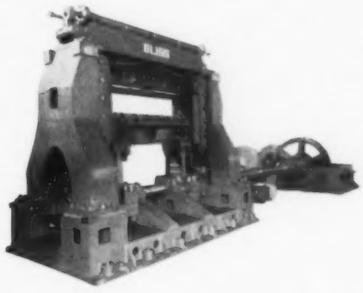


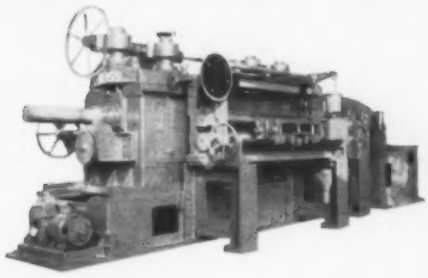
E.W. BLISS COMPANY

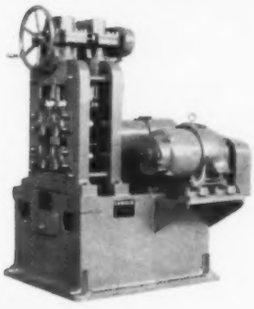
PRECISION PRODUCTION EQUIPMENT FOR

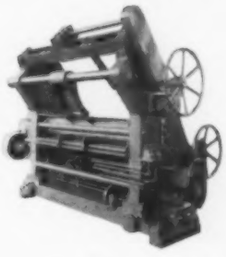
MILLS EQUIPMENT BEST BUILT

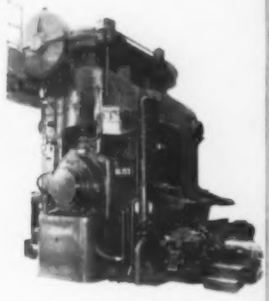


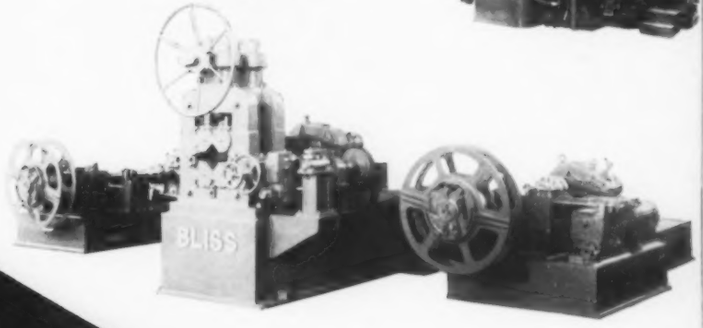












TOLEDO, O.

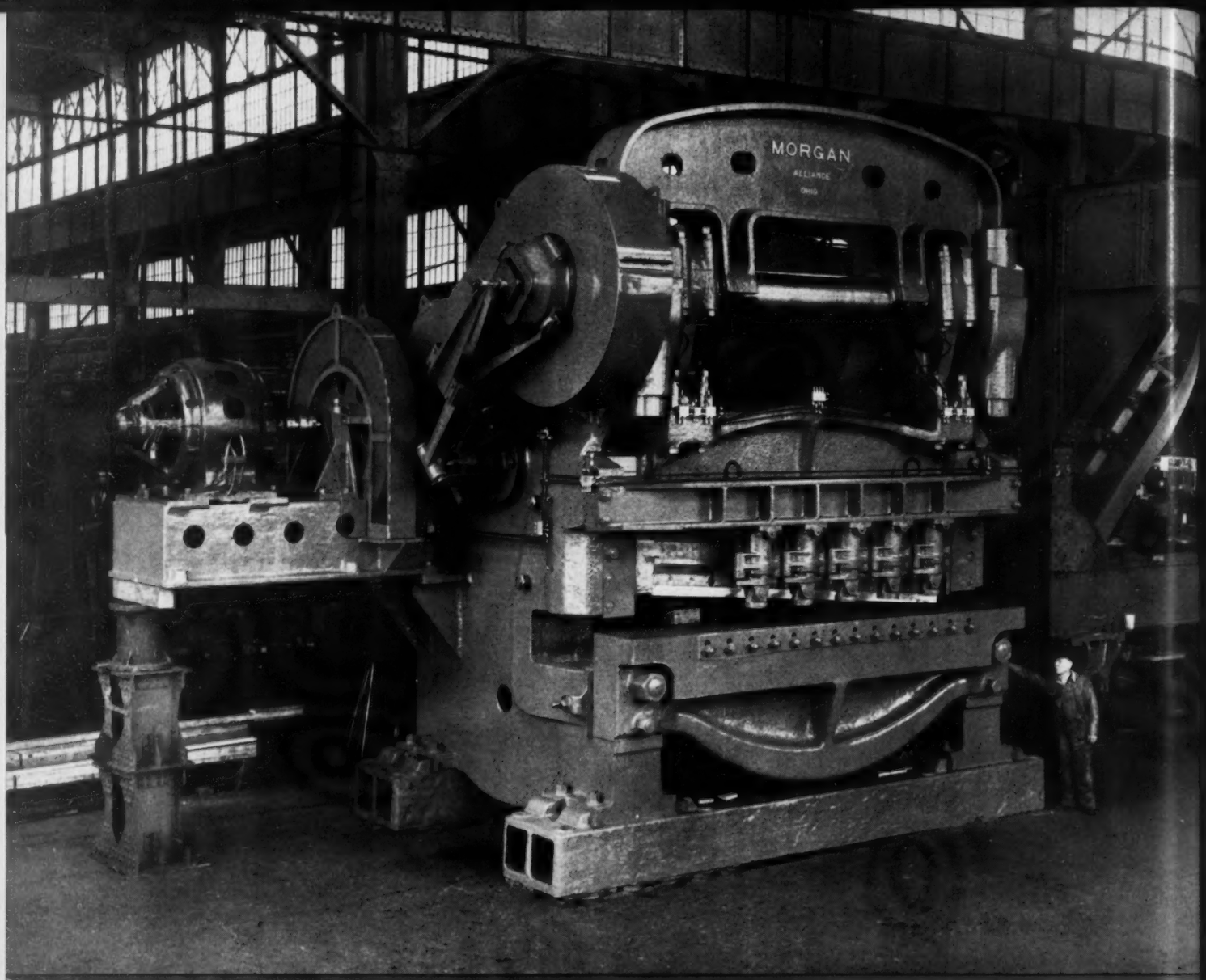
BLISS

SINCE 1857

AMERICAN OFFICES

BROOKLYN, N. Y.
CLEVELAND, OHIO
PHILADELPHIA, PA.
NEW HAVEN, CONN.
TOLEDO, OHIO
CHICAGO, ILL.
BOSTON, MASS.
DETROIT, MICH.
HASTINGS, MICH.
ROCHESTER, N. Y.
SALEM, OHIO

THE PLASTIC WORKING OF METALS



BUILT BY MORGAN *Engineering*

FOR SHEARING 2″ ARMOR PLATE

● Among the many types of mill equipment built by Morgan, is the 144″ plate shear illustrated above for shearing 2″ armor plate. Push button control is provided for operating the hydraulic clutch and hydraulic hold-downs. Of massive construction, this shear is typical of the type of mill equipment Morgan designs and builds. Morgan engineers rely upon a highly skilled shop organization, modern equipment and progressive ideas in building steel mill machinery.

DESIGNERS • MANUFACTURERS • CONTRACTORS
Blooming Mills • Plate Mills • Structural Mills
Electric Traveling Cranes • Charging Machines
Ingot Stripping Machines • Soaking Pit Cranes
Electric Welded Fabrication • Ladle Cranes
Steam Hammers • Steam Hydraulic Forging
Presses • Special Machinery for Steel Mills

THE MORGAN ENGINEERING CO.
ALLIANCE, OHIO

Pittsburgh, 1620 Oliver Building

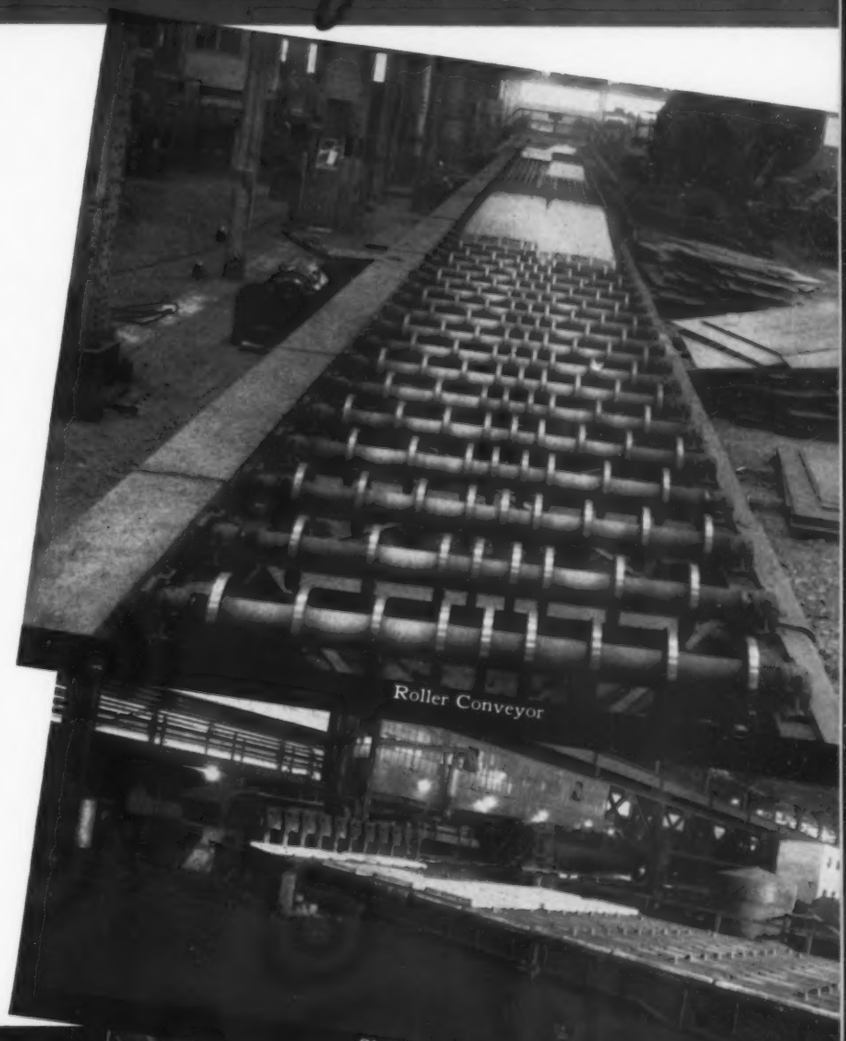
TREADWELL

Aids STEEL in its bid for VICTORY

These photographs show typical illustrations of TREADWELL ROLLING MILL MACHINERY. Jobs of this type demand engineering skill and expert knowledge of steel mill practice and problems. Complete yet flexible facilities are required for producing the right kind of equipment that will work right and need minimum maintenance.

TREADWELL has the organization and facilities.

Let us help you on your next job.



Roller Conveyor

Slab and Bloom Transfer

Plate Transfer with Runout Table

Cold Rolling Mills

Tables and Transfers

Cooling Beds

Coilers—Hot and Cold Strip

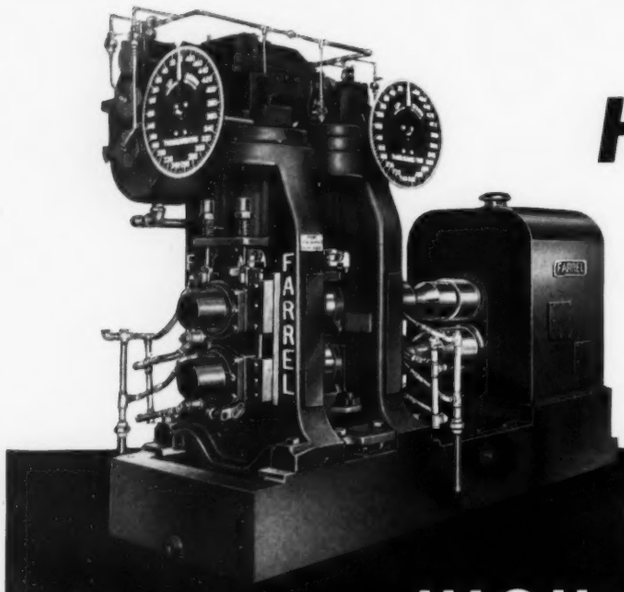
Merchant Mills

Special Machinery

Steel and Iron Castings

Treadwell Engineering Company

Easton, Pennsylvania



HIGH-SPEED MILL

FOR

COLD ROLLING HIGH CARBON STRIP

This Farrel Two-High Mill is specially designed to provide close control of gauge in continuous, high-speed cold rolling of high carbon steel strip.

Duplex control of the built-in screwdown is provided so that either screw can be operated independently or both screws synchronized through magnetic clutches. The screwdown is extremely high powered to permit adjustment of the gauge under full load.

The rolls are forged alloy steel, heat treated and hardened. They are carried in precision-type, flood-lubricated sleeve bearings, and are connected to the pinion stand with universal spindles. The heavy section, cast steel mill housings are designed for maximum strength and rigidity.

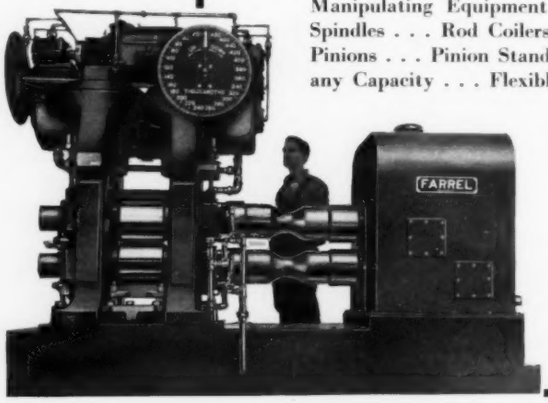
The mill is driven by an adjustable-speed reversing motor through a combined reduction gear unit and pinion stand, with Farrel-Sykes continuous tooth herringbone gears and mill pinions mounted in anti-friction bearings in a welded steel housing.

Farrel rolling mills for sheets, rods or strips are designed and built to fit individual conditions of operation. An experienced engineering staff is available to assist in working out applications to special production requirements.

FARREL ROLLING MILL MACHINERY

Rolls . . . Rolling Mills . . . Rod Mill Tables and Manipulating Equipment . . . Universal Mill Spindles . . . Rod Coilers . . . Gears . . . Mill Pinions . . . Pinion Stands . . . Gear Drives of any Capacity . . . Flexible Couplings . . . Roll Grinding Machines . . . Roll Calipers . . Lead Presses for Pipe or Rod.

★ ★

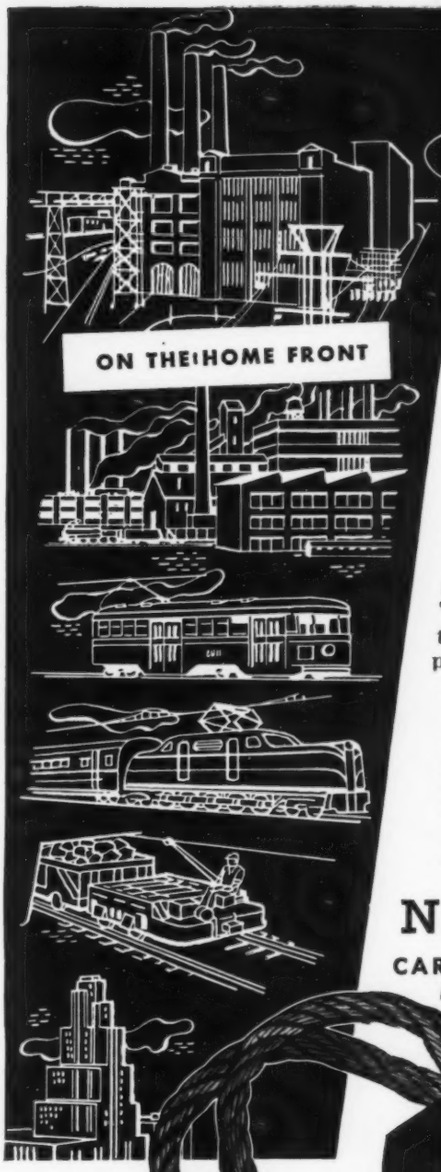


10" x 10" Two-High Rolling Mill for cold rolling high carbon steel strip.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.
Plants: Ansonia and Derby, Conn., Buffalo, N. Y. — Branch Offices: New York, Buffalo, Pittsburgh, Akron, Los Angeles

Serving Well!

ON THE HOME FRONT



ON THE BATTLE FRONT

"NATIONAL" Brushes are serving well with our armed forces and with industry at home. While the immediate demands of the emergency come first, every effort is being made to give all our customers the service to which they have been accustomed. When ordering "National" brushes observe these precautions to insure prompt delivery.

1 Anticipate your needs and order as far in advance as possible.

2 Give complete and accurate information on your original purchase order. Include samples and drawings when necessary.

3 Secure best possible priority rating.

NATIONAL
TRADE-MARK
CARBON, GRAPHITE AND METAL-GRAPHITE BRUSHES

LET'S GO! U.S.A. · KEEP 'EM FLYING!

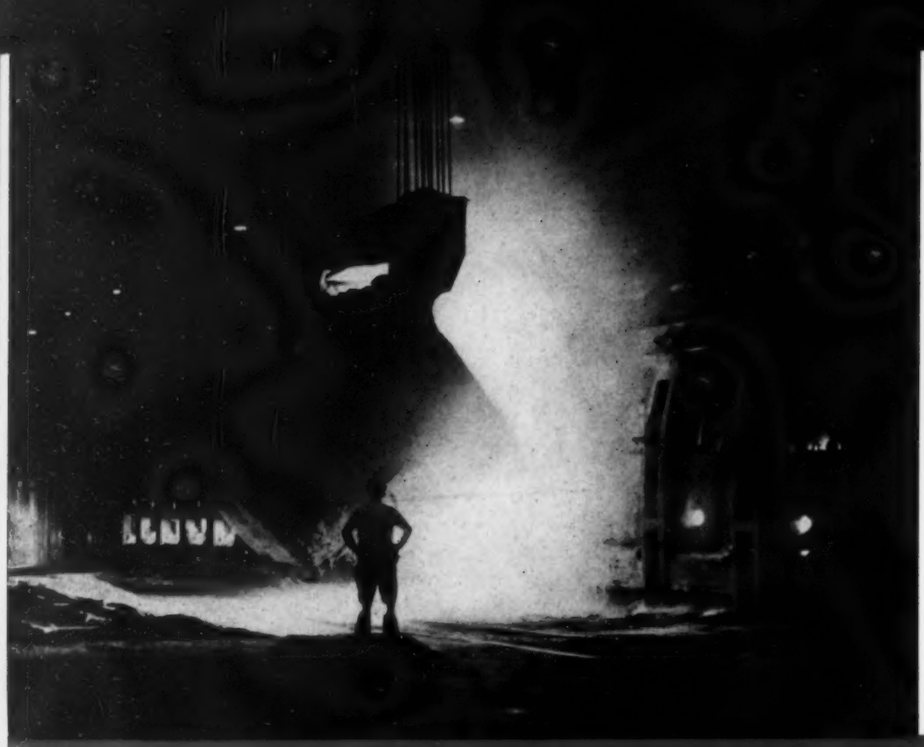
The word "National" and the three pyramids symbol △△△ are trade-marks of National Carbon Company, Inc.

CONSERVATION AND CARE WORK HAND IN HAND

In the present emergency it is particularly essential that your electrical equipment be kept running constantly and at full efficiency. Proper cleaning and elimination of minor faults will do much toward accomplishing this objective.

The Modern Pyramids Bulletins pictured above give practical suggestions on care and maintenance of brush-using electrical equipment. They are available to you without charge.

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
CARBON PRODUCTS DIVISION, CLEVELAND 1, OHIO
General Offices: 30 East 42nd St., New York, N. Y.
Branch Sales Offices: New York - Pittsburgh - Chicago - San Francisco



FOR INCREASED TONNAGE *in the* OPEN HEARTH

Over 6,000,000 Tons of Rimming Steel were made by 30 Steel Works during the past year with the use of our SODIUM FLUORIDE PROCESS.

It provides a larger yield of product with better quality.

Our Improved Equipment and Processes Include...

VENTURI PORTS . . . SLOPING BACK WALLS . . . DANFORTH-PETERSON CHECKERWORK . . . FUEL MIXING BURNERS . . . TAPERED DOOR FRAMES . . . SODIUM FLUORIDE PROCESS FOR RIMMING STEEL . . .

Over 90 Percent of the open hearth steel capacity use our improvements.

Adding Sodium Fluoride to the Ingot

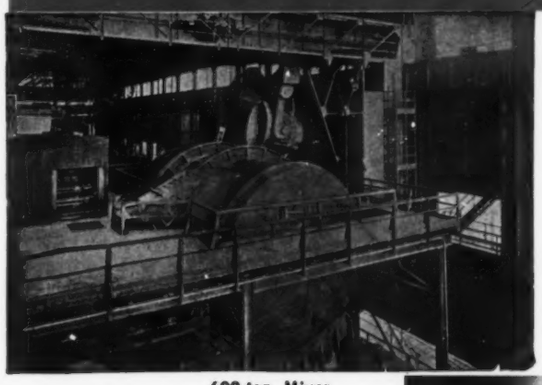
Open Hearth Combustion Company

GEO. L. DANFORTH, JR., Pres.

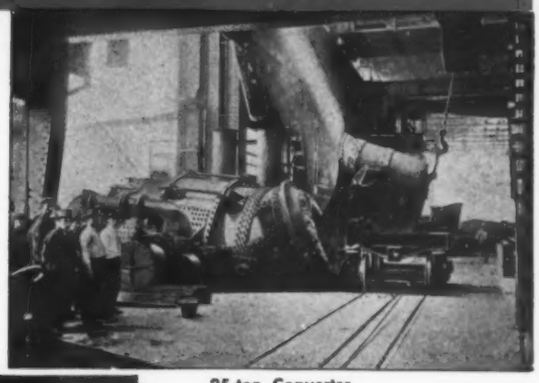
Engineers *Consultants* *Designers*

310 South Michigan Avenue Chicago, Illinois

CONVERTERS, MIXERS
TILTING OPEN HEARTH FURNACES
DUPLEX STEEL PLANTS



600-ton Mixer



25-ton Converter

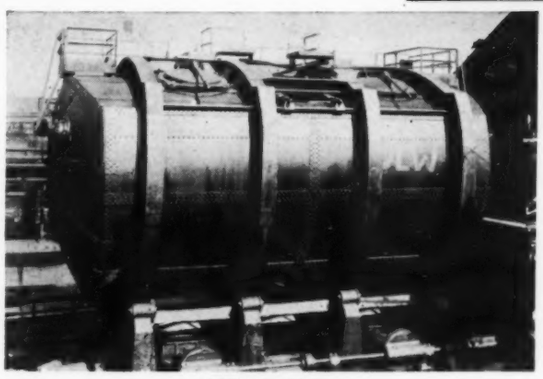
These pictures give but small evidence of Pennsylvania Engineering Works' contribution to the Steel Industry.

Backed by many years of experience and the great number of installations in the many Steel Plants, the Pennsylvania Engineering Works is prepared to design, fabricate and erect complete Duplex Plants, including Mixers—25 tons to 2000 tons capacity, Open Hearth Furnaces—50 tons to 400 tons capacity—both tilting and stationary, Coverters—5 to 50 tons capacity, Converter Jack Cars, Bottom Oven Cars, Regulating Valves, Slag Cars, Ladles, Ladle Cars, Transfer Cars, Jib Cranes and Hauling Systems.

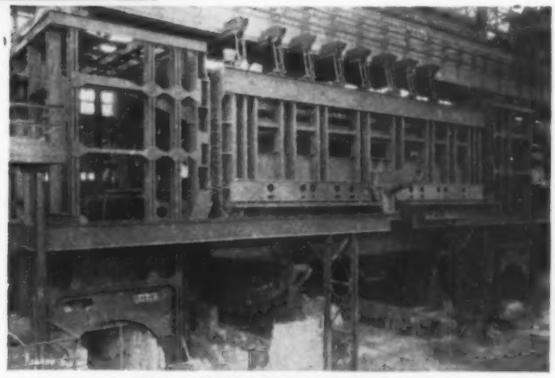
Blowing Charge in 15-ton Converter

Installations of some of the illustrated equipment at

Inland Steel Company
Tennessee Coal, Iron & Railroad Company
Youngstown Sheet & Tube Company
Carnegie-Illinois Steel Corporation
Republic Steel Corporation
Bethlehem Steel Company
American Steel & Wire Company
Weirton Steel Company
Jones & Laughlin Steel Corporation
Ford Motor Company, River Rouge
Ford Motor Company, England
Broken Hill Proprietary Company, Australia
Tata Iron & Steel Company, India
Algoma Steel Company, Canada
Steel Company of Canada, Ltd.
Compania Siderurgica del Mediterraneo, Spain
Cia. Fundidora de Fierro y Acero, Mexico



1500-ton Mixer



400-ton Tilting Open Hearth Furnace

Pennsylvania Engineering Works
New Castle, Penna.

DON'T let rollnecks be bottlenecks. Treat them considerately with Dixon's Rollneck Graphited Grease. Besides preventing undue wear or scoring of necks and brasses, this remarkable Dixon lubricant materially reduces the final cost of lubricant and lubrication labor. Especially valuable for mills with plain bearings. Remember these veterans too, must be kept rolling for Victory. For the proof, write Department RN-18.

NEW *Know-How Packages*

FOR

DIXON'S FLAKE GRAPHITES

Educational illustrations on the container and in 7 pages of booklet text firmly attached, show many a new lubricating and other application in which graphite can save time and equipment.

Available now in 5-lb. Ticonderoga No. 1 (large flakes), Ticonderoga No. 2 (medium flakes) and No. 635 (finely powdered flakes). Other sizes still come in the long-used containers, you know so well. From your regular suppliers', or write for printed C-18.

JOSEPH DIXON CRUCIBLE COMPANY, JERSEY CITY 3, N. J.

Canada: Canadian Asbestos Company · Montreal · Toronto · Vancouver · Winnipeg

Microfyne Graphite · Pipe Joint Compound · Graphite Seal · Graphited Oils · Gear Lubricants

Cup and Pressure Gun Grease · Waterproof Graphited Grease · Auto-Marine Grease

Graph-Air Guns · Lathe Center Graphite Lubricant · Belt Dressing (Contains no Graphite)

4252

the POWER THE ENGINE DELIVERS *gets a chance to* PAY ITS WAY

That's one reason why

AMERICAN LOCOMOTIVE CRANES

ARE SUCH HIGH PRODUCERS

Anti-friction bearings on AMERICAN Locomotive Cranes insure the delivery of maximum power to wheels and drums.

Ability to throw hoist and swing gears out of mesh makes full power available for travel.

Four models — 25, 30, 35 and 40 tons capacity. Gasoline, Diesel, Diesel-Electric.

Write for illustrated catalog — 600-L-1A.

60 Years of Safety 1883 - 1943 The Genuine CROSBY CLIP

AMERICAN HOIST & DERRICK CO

SAINT PAUL 1, MINNESOTA

Chicago · San Francisco · New York

AMERICAN TERRY DERRICK CO. . . . South Kearny, N. J.

Cuno at Zaporojstal

Significant of the wide acceptance of Cuno Non-Stop Filtration in wartime steel mills is this installation in the Zaporojstal Steel Mill, U. S. S. R.

All four independent lubricating systems of this great mill — gear reducer, pinion stands, roll neck bearing, and motor bearing systems—are continuously protected by Cuno Auto-Klean Filters, guarding against solids in vital lubricating oil which, if not removed, would cause damage or excessive wear.

Typical of these four systems is the one shown below which supplies oil to the roll neck bearings. The full flow of oil having a viscosity of 2300 SSU at 100° F. passes through the Cuno filter at the rate of 650 GPM.

All Cuno Auto-Kleans are cleanable while in operation — manually or automatically by motor drive. The metal discs which do the filtering are permanent.

On the great majority of continuous hot and cold strip mills in American and foreign countries, Cunos safeguard peak wartime production.

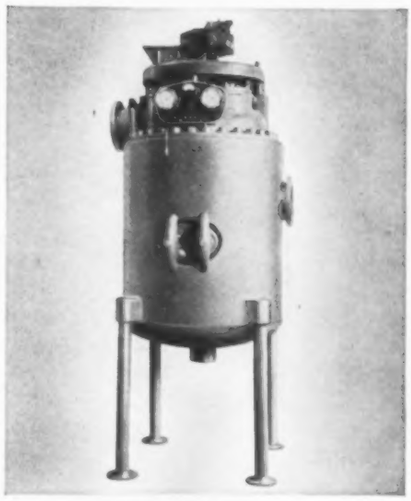
Write for free booklet "Quick Facts". Cuno Engineering Corp., 909 South Vine Street, Meriden, Connecticut.

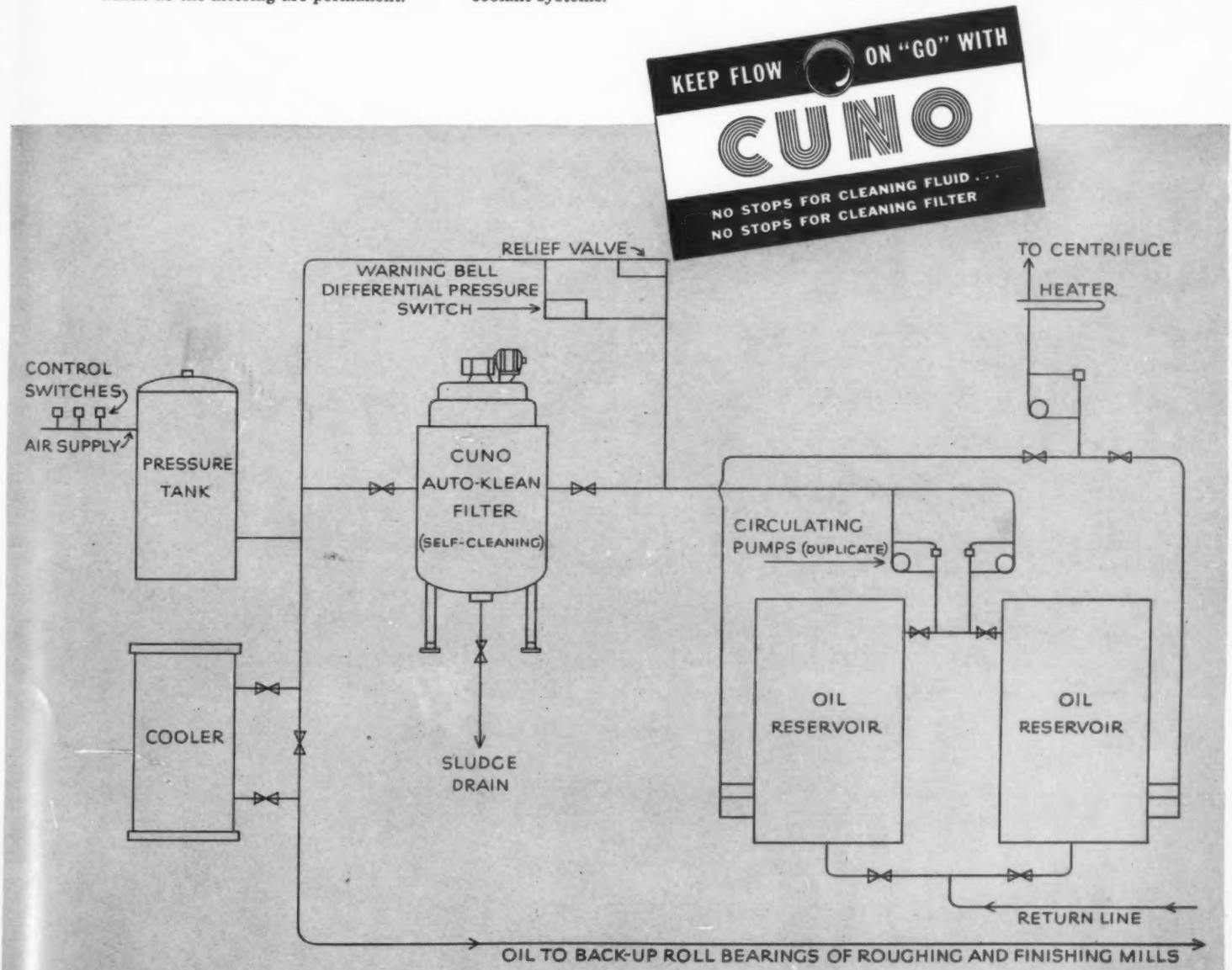
Non-Stop Production and Continuous Peak Protection

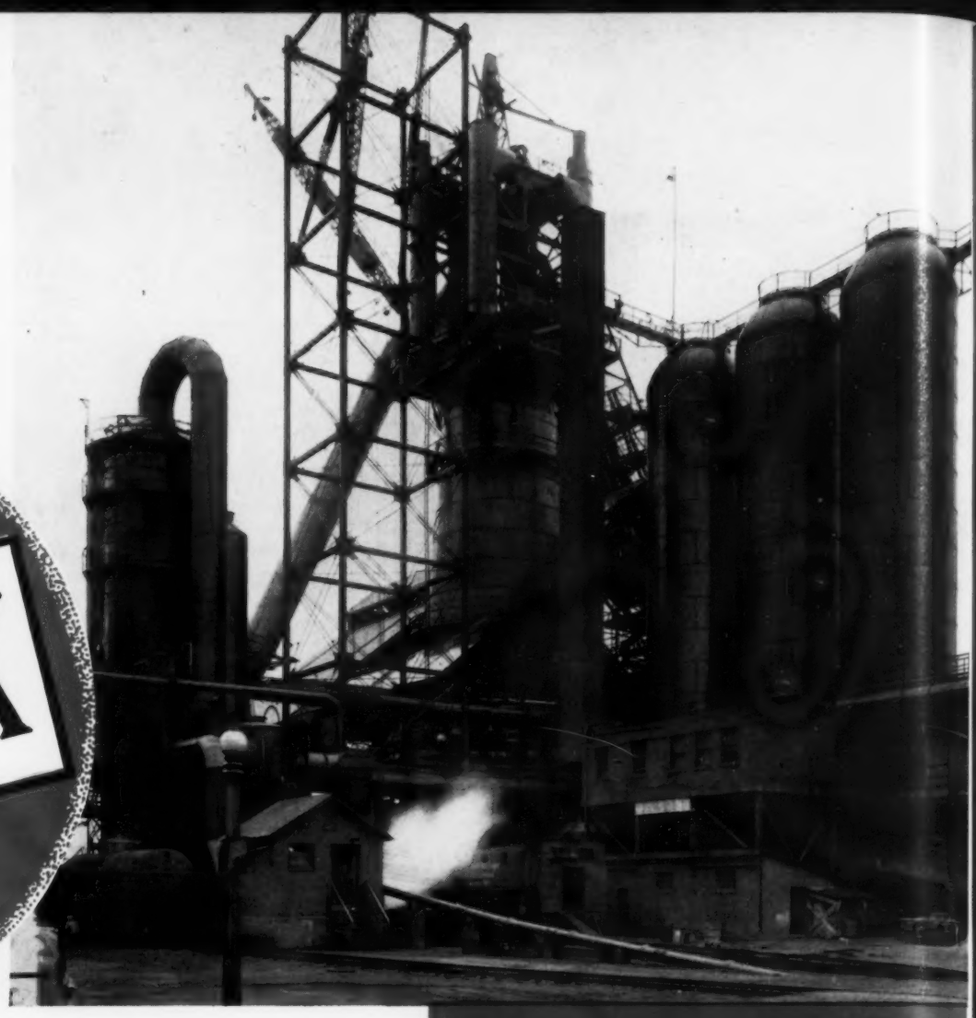
Cuno filters operate on edge-filtration principle— handle full-flow — are continuously cleanable (manually or automatically).

Cuno Auto-Klean (disc type): for lubricating and fuel oil systems as well as other industrial liquids.

Cuno Flo-Klean (wire-wound): designed especially for fluids of high abrasive content, i.e. descaling spray and roll body coolant systems.





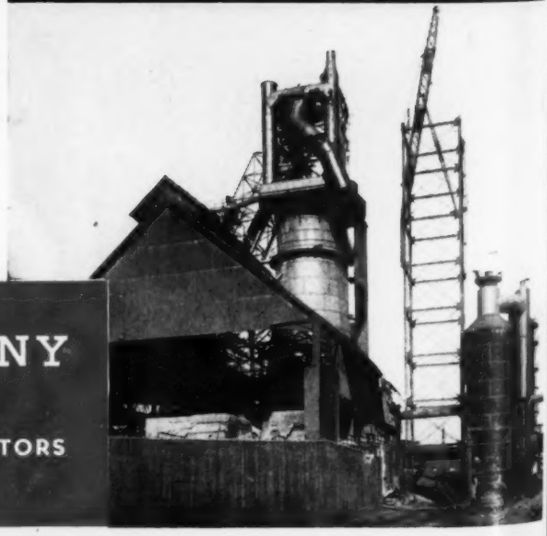


POLLOCK

A GREAT NAME IN BLAST FURNACE CONSTRUCTION SINCE 1863 . . .

Just because a company has been in business 80 years is no reason in itself for that company to continue to be a leader in its field, but if that company is still a leader after that many years, then there IS something to talk about.

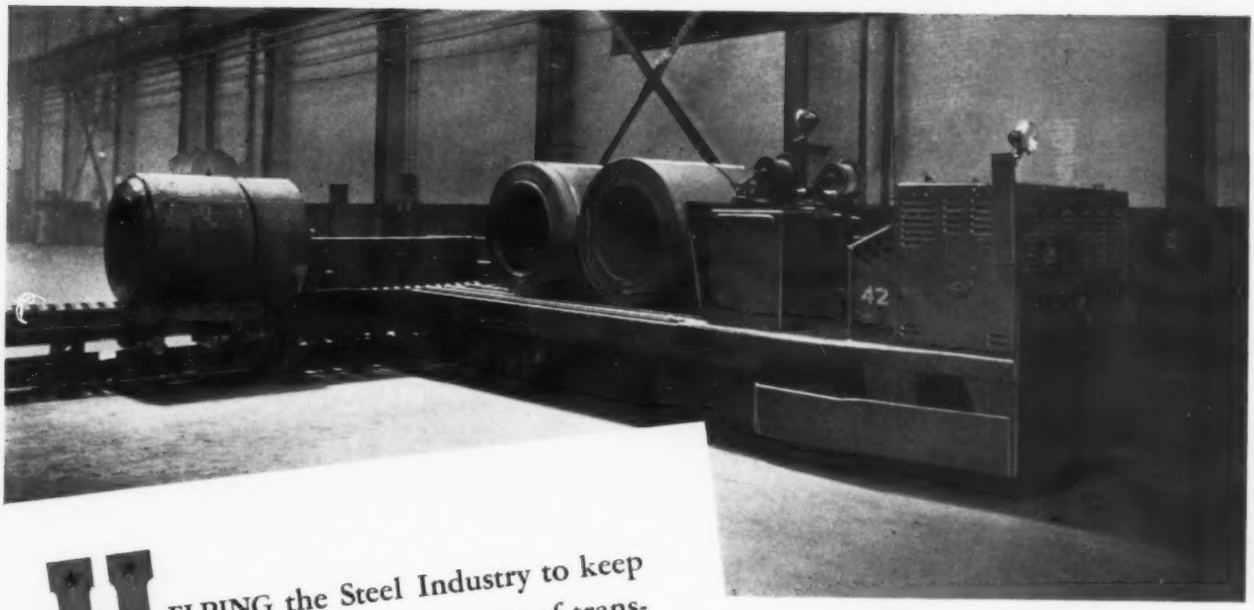
The William B. Pollock Company, after 80 years, is better able now in 1943 than ever before to take care of your blast furnace steel work requirements, and gladly offers you its services.



The WILLIAM B. POLLOCK COMPANY

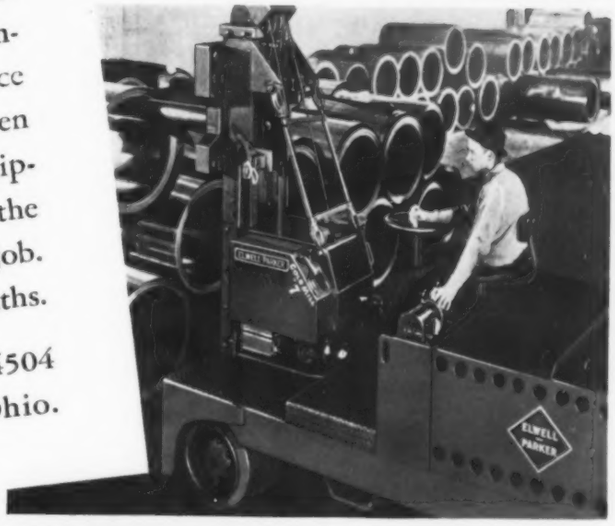
YOUNGSTOWN, OHIO

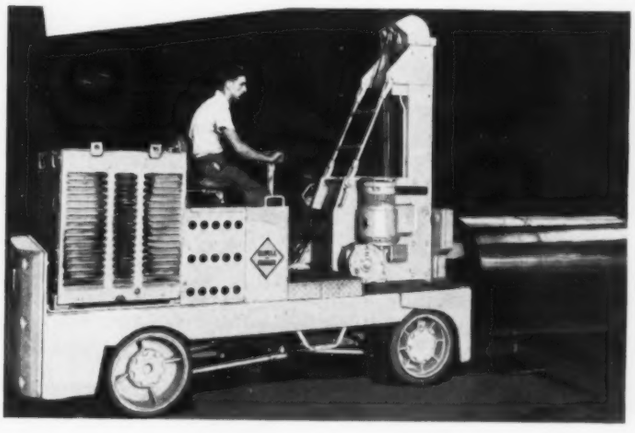
STEEL PLATE CONSTRUCTION • ENGINEERS - FABRICATORS - ERECTORS

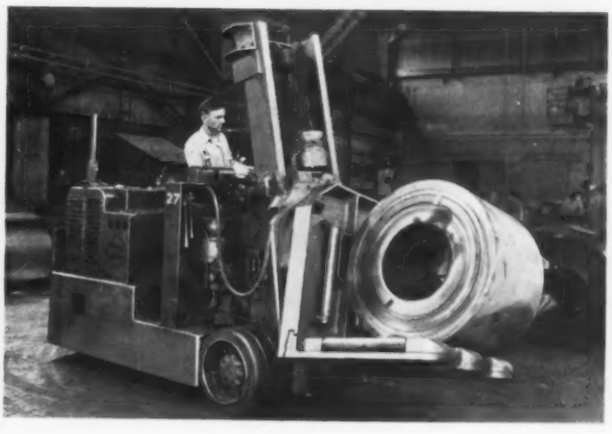


HELPING the Steel Industry to keep down the increasing cost of transporting its loads has been a continuous Engineering assignment here since the early 1920's. Sometimes it has been necessary to discard precedent. But the equipment we have designed and built for the Nation's great Steel Mills has done the job. Usually it has paid for itself within months.

The Elwell-Parker Electric Company, 4504 St. Clair Avenue, Cleveland 14, Ohio.







ELWELL-PARKER

POWER INDUSTRIAL TRUCKS AND CRANES

1893 ★ 1943 · The Elwell-Parker Year ★ 1943

Motors Run Longer Cooler Cleaner

— *and* short circuits are practically eliminated with drip-less, waste-less NON-FLUID OIL. It does not creep out of bearings, nor is it thrown onto windings by vibration.

Therefore insulation is kept clean and burn-outs eliminated. Motors run cooler because NON-FLUID OIL stays in bearings and lubricates dependably. Motor frames are kept clean. Lubricating expense is less because NON-FLUID OIL outlasts oil many times.

Used successfully in leading iron and steel mills. Send for instructive bulletins.

•

New York & New Jersey Lubricant Co.

Main Office: 292 Madison Ave., New York 17, N. Y.

WAREHOUSES:

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TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT. OFFICE & FOREIGN COUNTRIES

MODERN STEEL MILL LUBRICANT

Better Lubrication at Less Cost per Month

MORGANITE BRUSHES

. . . meeting industry's vast production needs

In every type of motor, generator and dynamotor—in both main and auxiliary drives—MORGANITE brushes are vital to essential-industrial production. They have the 'guts' to consistently deliver; engineers and production men know these brushes by past performances.

MORGANITE brushes eliminate service interruptions, tie-ups and work stoppages. The remarkable results achieved for industry over the years, are now being duplicated and even surpassed for the war-effort.

MORGANITE engineers will gladly collaborate in the solution of your brush problems; your inquiries are invited.

WRITE FOR DATA BOOKLET

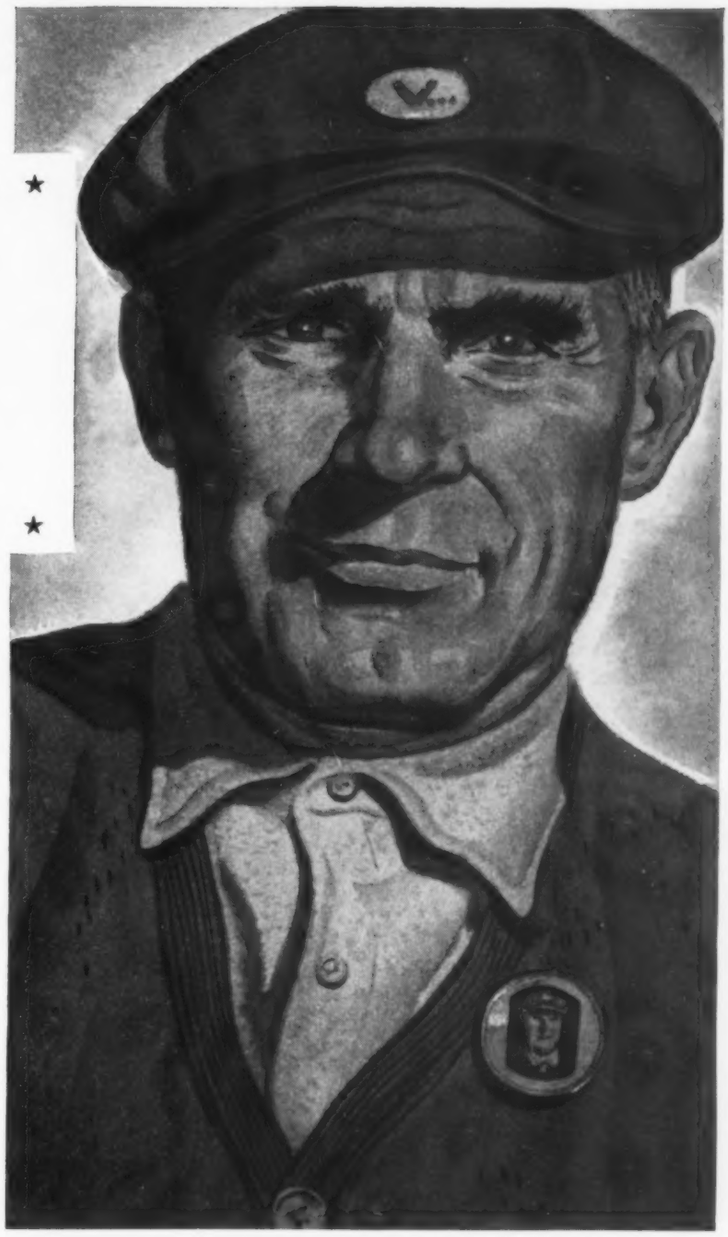
The MORGANITE 30-page informative booklet is available on request without obligation. The correct type, body, material and application are described in detail.

MORGANITE BRUSH CO.
INCORPORATED
LONG ISLAND CITY, NEW YORK

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Manpower Is Critical

★ ★ ★ ★ ★ ★ ★ ★ ★ ★



Our dwindling supply of manpower is rapidly becoming the most critical shortage of our immense wartime program. This acute condition imposes a great hardship on our war industries producing fantastic quantities of planes, ships, tanks and numerous other weapons of war.

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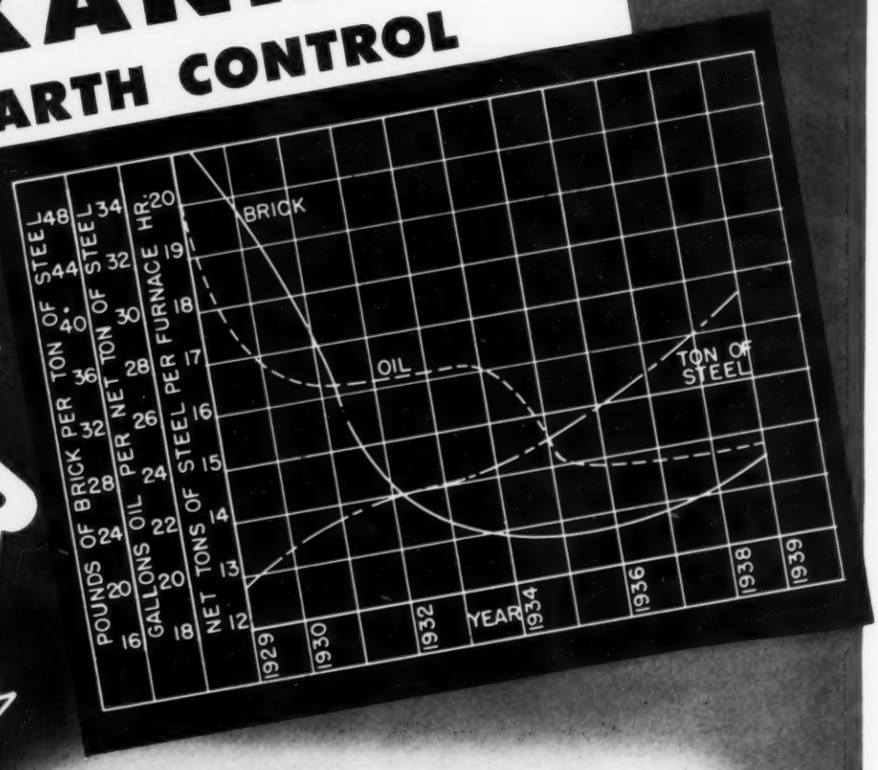

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MORE TONS PER FURNACE HOUR

The chart above shows how complete automatic control proves its value over a period of years.

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Write for your copy of Bulletin No. 115 which tells the whole story.

* Published reports show a total new capacity of 6,345,000 tons.

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AUTOMATIC CONTROL

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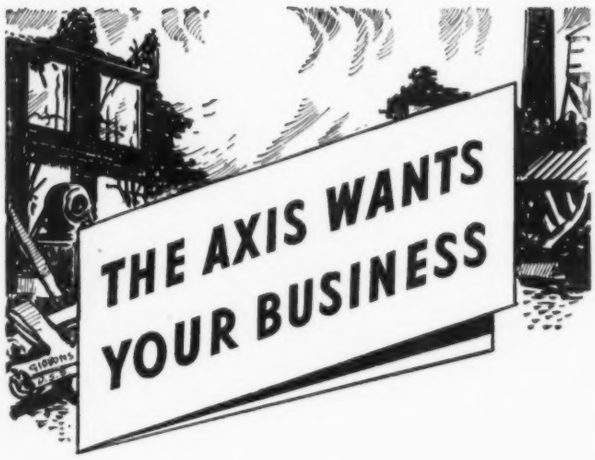

THIS is more than a war of mechanical monsters clashing in the night . . . more than a war of production.

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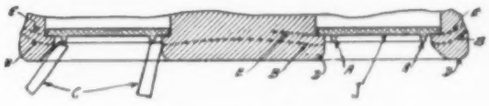

Note wear line B B B

There are no holes or depressions to start wear or cracks.

These features result in

LOW MAINTENANCE COST.

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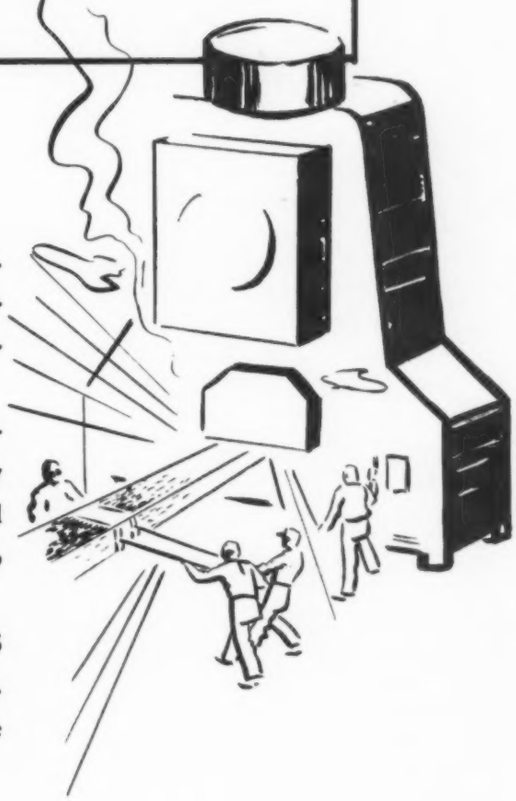

A forging press or a rolling mill is no place for "cold" steel. The delivering of billets uniformly heated to the right temperature calls for skillful furnace engineering and well-designed burners.

Let Bloom Engineering show you how the proper application of modern burners can produce ideal results. In many cases, greatly improved heating conditions are obtained through relatively simple alterations, and with little or no disturbance to present operations.

Furthermore, with BLOOM LONG-FLAME BURNERS you can convert INSTANTLY from gas to oil or oil to gas.

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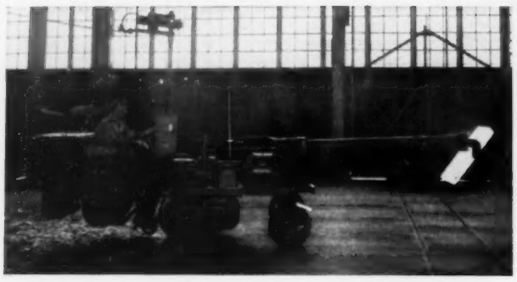
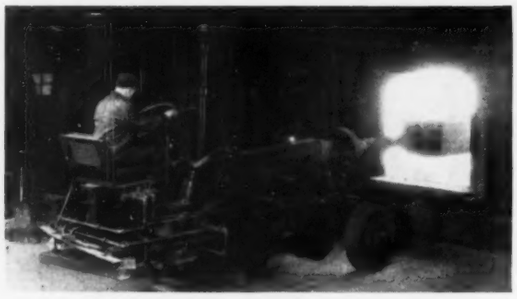
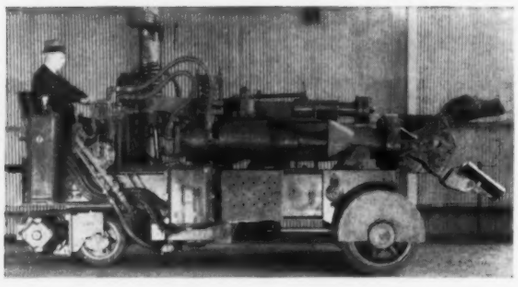
SPEEDING PRODUCTION WITH BROSIUS EQUIPMENT







Speeding up production to shorten the war is vitally necessary and Brosius Charging and Manipulating Machines, built in capacities of from 2,000 to 20,000 pounds, are aiding very materially.

The 2,000 pound capacity Brosius Tongs Charger, (shown left top), handles billets between heating furnace and mill. It requires a minimum operative space, solving many difficult operative problems in congested areas. Operator experiences no difficulty in handling as it is easy to operate and is hydraulically steered.

The center left illustration shows a Brosius 4,000 pound capacity Charging Machine, designed to handle charging boxes for serving melting furnaces. This machine serves two 35 ton open hearth furnaces and handles a standard 5′0″ box.

The bottom left illustration shows a Brosius 6,000 pound Manipulator. This machine handles billets, shell blanks, gun barrel blanks, etc.; charging and drawing the heating furnaces and manipulating the piece under hammer or press while being forged.

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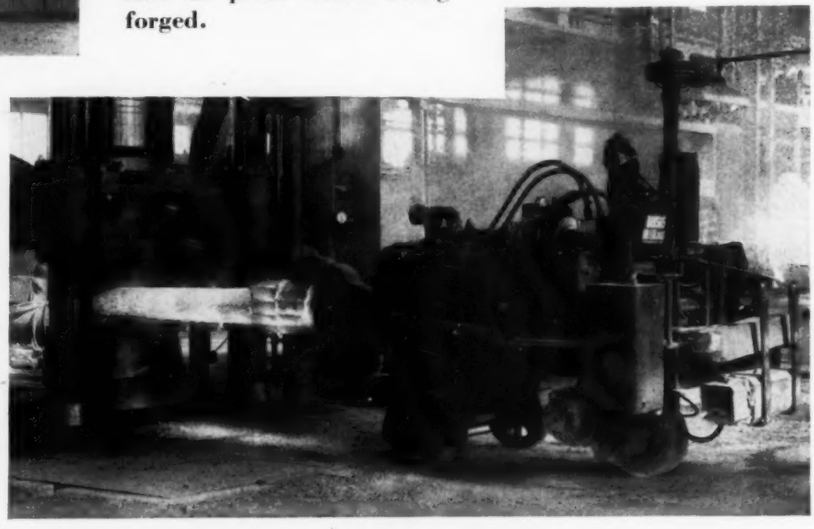

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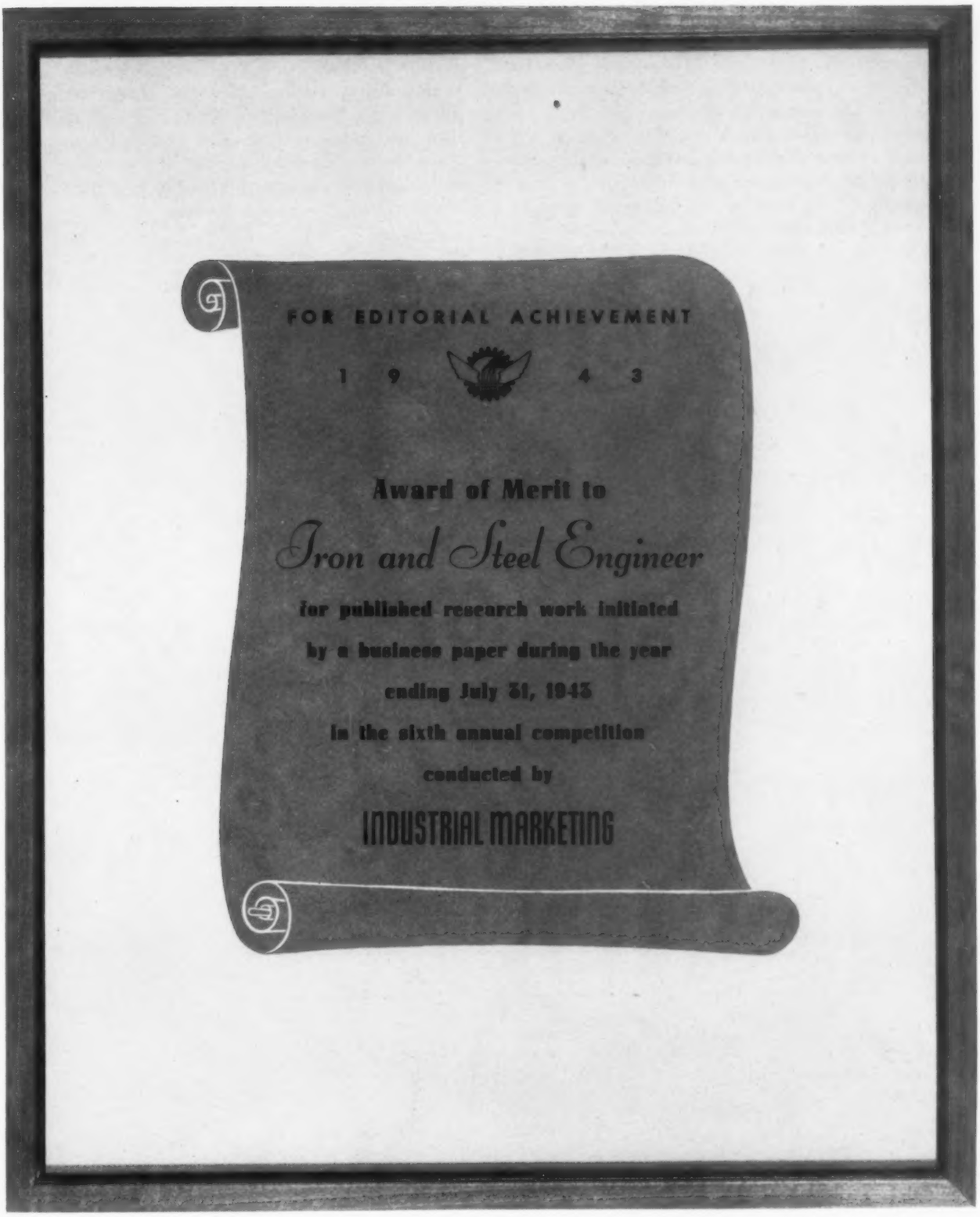
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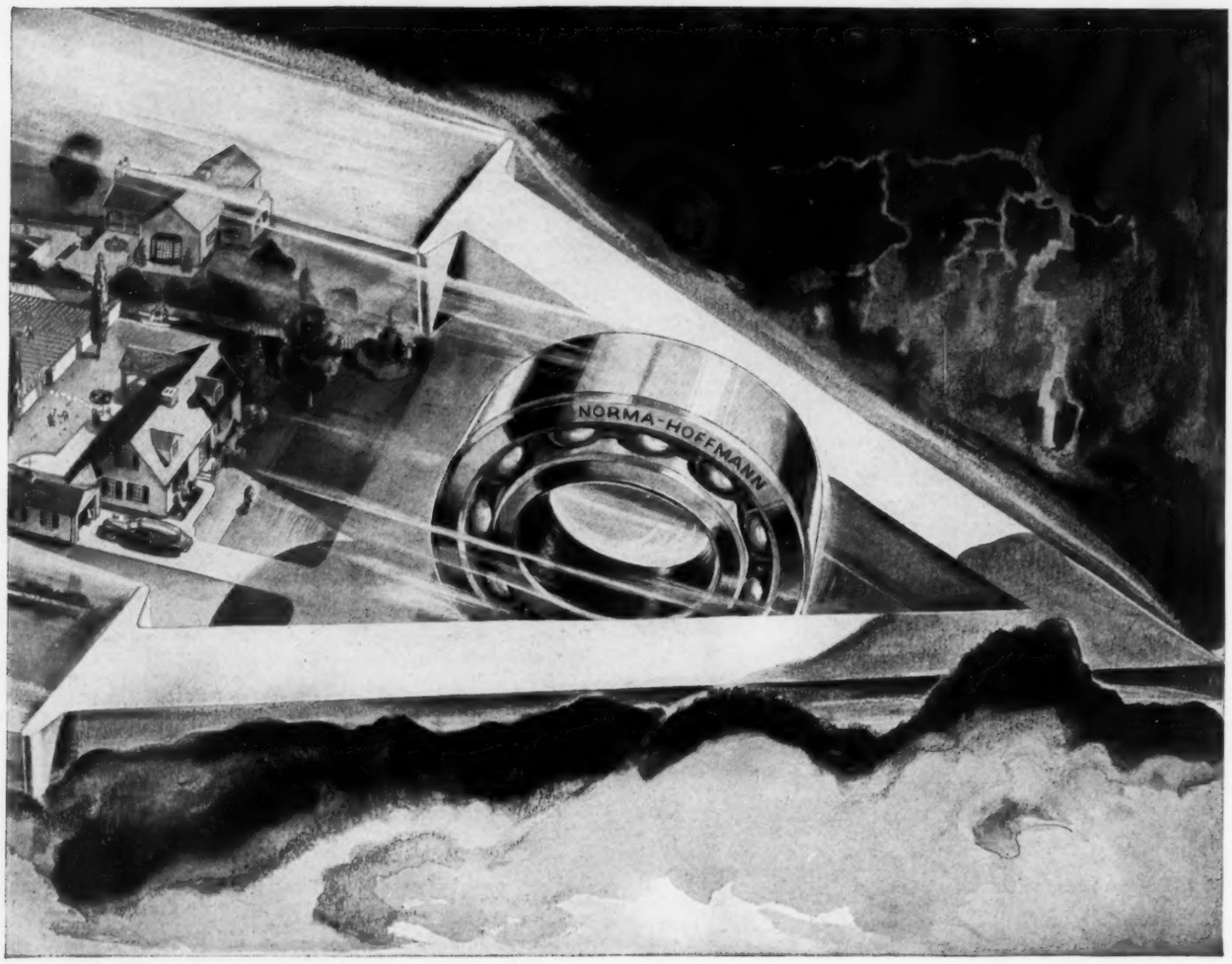

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